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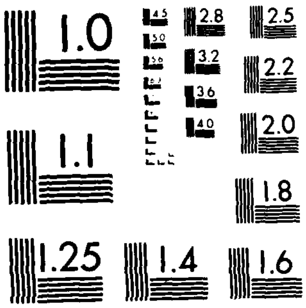

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THE IDA/BPT CRISIS RELOCATION PLANNING MODEL: DESCRIPTION, DOCUMENTATION AND USERS' GUIDE TO THE COMPUTER PROGRAM

Edward S. Pearsall, BPT
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Performed under subcontract for
Institute for Defense Analyses

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2300 Terova Drive
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This report describes work performed by Bushnell, Pearsall and Trozzo, Inc., under subcontract with the Institute for Defense Analyses on Task A-1 of IDA Contract No. EMW-C749 with the Federal Emergency Management Agency. Task A-1 calls for the development of a "model to simulate population movement during an evacuation from the risk area to the various host areas over a transportation network."

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This report describes, documents and provides a user's guide to a system of computer routines which perform the various computations required to apply a crisis relocation model developed jointly by IDA and BPT, Inc. The computer routines together comprise an interactive system resident on the FEMA Univac 1108 facility. The model and its attached national data base can be used to analyze in detail the evacuation of risk areas anywhere in the continental United States under a wide range of different assumptions regarding the assignment of reception areas and the performance of the transportation system during the evacuation.

Section 1 of the report is a detailed description of the IDA/BPT crisis relocation model. The four basic elements of the model are: 1) a transportation network data base which can be accessed up to 10 states at a time to construct regional highway networks at the county level, 2) a crisis relocation planning submodel to compute (or accept as input) an assignment of evacuees to reception areas, 3) a route selection and loading algorithm which generates routes and computes traffic to approximate the loadings which would result if evacuees were free to chose their own routes, and 4) an evacuation simulator, which determines the location of evacuees on the network as a crisis relocation proceeds. Section 2 is a user's guide to the programs and Section 3 is an annotated sample run illustrating program usage, input and output. Supporting material is contained in five appendices.

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Contract No. EMW-0749
Task A-1

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INTRODUCTION

This report describes work performed by Bushnell, Pearsall and Trozzo, Inc., under subcontract with the Institute for Defense Analyses on Task A-1 of IDA Contract No. EMW-C-0749 with the Federal Emergency Management Agency. Task A-1 calls for the development of "a model to simulate population movement during an evacuation from the risk area to the various host areas over a transportation network."

This report describes, documents and provides a user's guide to a system of computer routines which perform the various computations required to apply a crisis relocation model developed jointly by IDA and BPT, Inc. The computer routines together comprise an interactive system resident on the FEMA Univac 1108 facility. The model and its attached national data base can be used to analyze in detail the evacuation of risk areas anywhere in the continental United States under a wide range of different assumptions regarding the assignment of reception areas and the performance of the transportation system during the evacuation.

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own routes, and 4) an evacuation simulator, which determines the location of evacuees on the network as a crisis relocation proceeds. Section 2 is a user's guide to the programs and Section 3 is an annotated sample run illustrating program usage, input and output. Supporting material is contained in five appendices.

1.0 Description of the Model

The IDA/BPT crisis relocation model consists of four major components each with its own distinct function and its own set of computer routines. These components are:

1. A transportation network in the form of a national data base describing the U.S. highway system and providing information at the county level on population, area, and risk. The computer routines allow users to assemble, store and retrieve regional networks comprising up to 10 states.

2. A crisis relocation planning submodel enabling users to directly input an evacuation plan or to compute a plan as the solution to a transportation problem constructed at the user's direction.

3. A route selection and loading algorithm which generates routes and assigns traffic to the routes in a way which approximates the loadings which would actually result if evacuees were free to choose their own routes and received accurate traffic information during a crisis relocation.

4. An evacuation simulator designed to show the location of evacuees and the traffic distribution on the highway network at various elapsed times from the start of an evacuation.

1.1 The Transportation Network

The BPT/IDA model incorporates a national data base describing the U.S. highway system and providing other information at the county level. The data base was originally assembled by IDA in 1981 under a FEMA contract. Further information on county areas, 1980 population and vulnerability to attack was added by BPT under the subcontract.

In its present form the data base consists of three files holding the following:

Node File - Information for a set of approximately 3700 locations coinciding with population centroids and interchanges on the highway system. At least one node is located within each county in the continental U.S.

Link File - Information for a set of approximately 8700 two-way segments of highway joining nodes within the continental U.S.

Map File - A short file indicating the location of the information for each state within the Node and Link files.

Annotated partial dumps of the Node File and the Link File are provided in Approdix 4.5. A complete listing of the Map File is also given in the appendix.

The Node File contains the following items for each location in the data base:

- the location's 5-digit state/county FIPS code. The first 2 digits of the code designate the state; the last 3 digits designate the county within the state.
- a single-digit sequence number for the location within the county. A sequence number zero (0) indicates the population centroid for the county. Every county in the continental U.S. has a single population centroid and may have additional nodes at important highway intersection points.

- northing and easting; the number of miles north and east from a reference point set beyond the southwest boundary of each state.

- a flag indicating whether or not the location is a major urban center (1 = urban, 0 = nonurban).

- place name; the name of the closest city, town or village.

- county name.

- latitude and longitude in degrees. Additionally, for nodes that are county population centroids, BPT has added the following items:

  - population of the county according to the 1980 Census.

  - area of the county in square miles.

  - a 2-digit code corresponding to FEMA's classification of the county for crisis relocation planning purposes. The first digit classifies counties according to risk in a countervalue attack as follows:

    0 - county not at risk
    1 - (A) county evacuation plan exists
    2 - (B) major metropolitan center; high risk
    3 - (C) intermediate-sized city; moderate risk
    4 - (D) small city or military installation; lower risk

    The second digit is a flag designating counties which have significant counterforce targets within their boundaries.

The Link File contains the following items for each two-way segment of the transportation network:

- the 5-digit FIPS code and sequence number for each end of the segment.

- the northing and easting of the two ends of the segment.

- a 2-digit code indicating the characteristics of the highway segment. The first digit designates the highway as 1 - Interstate, 2 - a U.S. Route, or 3 - a State Road. The second digit classifies the highway segment as follows:

1 - a 6-lane Interstate
2 - a 4-lane Interstate
3 - a 4-lane limited access highway
4 - a 4-lane unlimited access highway
5 - a 2-lane primary road
6 - a 2-lane secondary road
7 - a 2-lane poor quality road

- the Interstate, U.S. Route or State Road number.

For purposes of analyzing transportation problems during a crisis relocation, it is rarely necessary to perform the computations in a way which treats the continental United States as a single integrated unit. The movements of, say, Michigan's urban residents along that state's highways have little practical impact upon similar movements in New York or California. Consequently, an evacuation of Michigan's cities can be effectively studied within the context of a regional network encompassing Michigan and, possibly, several neighboring states. The IDA/BPT model is designed to economize on computer storage and processor time by utilizing only those parts of the national transportation data base which are relevant for a particular application.

The model operates on regional networks of up to 10 states which are assembled state by state from the information contained in the national data base. The states that are included in a single region need not be contiguous although one would normally expect them to be so.

In order to facilitate later computations, a certain amount of preprocessing is performed on the node and link information culled from the national data base as a regional network is assembled. Nodes are renumbered sequentially and link endpoints are equated to the renumbered nodes. Each bi-directional highway segment of the data base is also recast as a pair of uni-directional links. These links are then sorted by origin so that the data for all of the links with a common origin

(or destination, since the network is symmetric) can be retrieved sequentially.

Finally, the distance, speed and capacity of each link is computed using the information from the data base and parameter values supplied by the model user:

Distance - Link distances are computed as the straight line distance between the end points of each link using the northings and eastings from the Link File.

Speed - Speeds are assigned by road categories as follows for normal (nonevacuation) movements along the network.

Class 1-3, Interstates and other 4-lane limited access roads - 55 mph.

Class 4, Primary unlimited access 4-lane - 45 mph.

Class 5, Primary unlimited access 2 lane - 40 mph.

Class 6-7, Secondary and poor quality roads - 30 mph.

Speeds for crisis relocation (evacuation) movements are supplied by users for the same road categories.

Capacity - For normal movements the network is regarded as uncapacitated; for crisis relocation the user supplies parameter values for the vehicles per lane per hour using the same road categories as speed. These values are multiplied by the number of lanes to obtain the capacity in each direction.

The number of lanes available in each direction is partly a function of traffic control during an evacuation. Users of the IDA/BPT model may choose among three options for controlling traffic during an evacuation.

Normal Traffic Control - Two-way traffic on all highway segments. The number of lanes in each direction is one-half the number of lanes given in the data base.

One-Way Outbound Traffic Control - One-way traffic on all congested highway segments. All lanes of these segments are assigned to the outbound link. Inbound links for these highway segments are assigned zero capacity.

Variable Lanes Traffic Control - All lanes are available to traffic in both directions. In effect, the model combines the traffic and available capacity in both directions along a highway segment.

Since the assembly of a regional network from the Node, Link and Map files is a somewhat tedious job, the computer program which implements the model provides for the storage and retrieval in preprocessed form of up to 10 regional networks.

1.2 The Crisis Relocation Planning Submodel

Within the IDA/BPT evacuation model, a crisis relocation plan is functionally defined as a set evacuation/reception county pairs and the numbers of evacuees to be relocated from the evacuation counties to the reception counties. Users of the model have the option of specifying the evacuation plan directly or supplying other information from which a linear program is constructed and solved to obtain an evacuation plan. This section describes the computation of an evacuation plan which conforms to criteria specified by the model user.

The linear program which is solved to obtain an evacuation plan is known, technically, as a transportation problem. Formally, the problem has the following mathematical statement: Let $i = 1, M$ designate origin counties, $j = 1, N$ designate destination counties, and X_{ij} denote the number of evacuees to be relocated from origin i to destination j. Let S_i, $i = 1, M$ be the numbers of evacuees to be relocated from the evacuation counties, let D_j, $j = 1, N$ be the capacities in numbers of evacuees that can be accommodated in the reception counties and let t_{ij} be the time it takes to travel over the transportation network from evacuation county i to reception county j. Then, the linear program which is solved to obtain an evacuation plan is:

Find: $X_{ij} \geqq 0$ for all i and j

To Minimize: $\sum_i \sum_j t_{ij} X_{ij}$

Subject to: $\sum_j X_{ij} \geqq S_i$ for all i

$\sum_i X_{ij} \leqq D_j$ for all j

An efficient algorithm for solving transportation problems has been incorporated into the computer routines which implement the IDA/BPT transportation model. This algorithm is applied to solve transportation problems which are constructed employing information supplied by users. The nonzero components of the solution to the transportation problem constitute an evacuation plan.

The elements of the transportation problem which are specified directly or indirectly by users of the IDA/BPT model are the evacuation counties and the number of evacuees, S_i, i = 1, M, and, the reception counties and the reception capacities, D_j, j = 1, N. The times, t_{ij}, are computed as the normal travel times over the regional highway network from the population centroids of the evacuation counties to the population centroids of the reception counties. The times are determined for normal speeds over the shortest route. The rationale for inserting normal travel times into the transportation problem is, first, that the generally slower speeds of travel during an evacuation have little effect on the choice of the shortest routes and, second, a great deal of traffic at normal speeds can be expected following the relocation between an evacuation county and its reception counties. This traffic is necessary to support the relocated population and, possibly, to maintain production and services within the evacuated county.

A list of evacuation counties together with the number of evacuees from each county can be specified directly by the user. Alternatively, evacuation counties in a region can be selected according to risk categories given in FEMA's Crisis Relocation Conglomerate Listing. These categories are:

A - counties for which crisis relocation plans already exist; usually because a major military installation is located within the county.

B - the most densely populated counties; counties containing major metropolitan areas which could be targeted in the event of an attack.

C - heavily populated counties; usually the counties contain a major city with a population of several hundred thousand.

D - less densely populated counties; counties containing either a concentration of population and industry or a military installation which could make the county a target in the event of an attack.

The IDA/BPT model allows users to specify evacuation counties as 1) all A counties, 2) all B counties, 3) all B and C counties, 4) all A, B, C and D counties. In addition, FEMA's Crisis Relocation Conglomerate Listing designates those counties which would be threatened in the event of a counterforce attack. These counterforce targets can be added to the list of evacuation counties by users of the model.

The number of evacuees from each evacuation county selected in this way is computed using a set of rules as follows:

1. If counterforce targets are included in the list of evacuated counties, then all counties with counterforce targets are completely evacuated. The number of evacuees is set equal to the county's 1980 population.

2. All other counties are evacuated down to the point where the remaining population meets both of the following criteria:

    a. The population following evacuation does not exceed a percentage of the county's residents specified by the user, e.g., 10 percent.

    b. The population density does not exceed a number of people per square mile specified by the user, e.g., 200 people per square mile.

The designation of reception counties is similar to the designation of evacuation counties. Again, users have the option of directly

specifying these counties and their capacities to hold evacuees. Alternatively, the following rules can be applied to establish a list of reception counties:

1. No evacuation county is simultaneously allowed to serve as a reception county.

2. No county is permitted to be a reception county if its resident population density is less than a specified minimum value such as 10 people/square mile. The purpose of the minimum density is to exclude as reception counties areas such as mountains and deserts which cannot support significant numbers of evacuees.

3. No county is permitted to be a reception county if its resident population exceeds a specified maximum value such as 500 people/square mile. The maximum density limit enables the model user to exclude counties which are already heavily populated but have not been designated as evacuation counties.

All counties within a region which are not excluded by 1-3 above are included as potential reception counties. The number of evacuees each potential reception county can hold is computed according to the following criteria:

1. The population of a reception county following an evacuation cannot exceed a user-specified multiple of the county's original population. For example, a multiple of three would limit the capacity of reception counties to no more than two evacuees for each resident. By limiting reception capacity in this way users can prevent the model from assigning more evacuees to a reception county than the local infrastructure can support.

2. The population density following the evacuation does not exceed a number of people per square mile stipulated by the user, i.e., 500 people/square mile. This maximum limit lets users prevent the creation of potential countervalue targets in reception counties.

The model also allows users to establish a geographic band of preferred reception counties around each evacuation county. The inner and outer limits of these bands are stipulated by the model user in the form of a minimum and a maximum normal travel time. For example, limits of

one-half hour and two hours would have the effect of establishing a band of preferred reception counties within commuting distance of most population centers.

The travel time limits are used to modify the coefficients, t_{ij}, of the transportation problem. If the normal travel time between an evacuation county and a reception county falls outside the limits, then 1,000 hours is arbitrarily added to the normal shortest route time between the two counties. The effect of this change is to make the model select evacuation plans in which the reception capacity within the preferred counties is entirely used up before any evacuees are assigned to reception counties outside the travel time limits. In the example given, the solution to the transportation problem would strongly favor assignments of evacuees to reception counties between one-half hour and two hours normal travel time from their homes.

1.3 The Route Selection and Loading Algorithm

The heart of the IDA/BPT crisis relocation model is an efficient algorithm for finding routes along the regional transportation network and then determining the traffic the routes would carry during an actual evacuation. The end product of the route selection and loading algorithm is a list of routes, no-less-than one for each evacuation/reception county pair in the crisis relocation plan, with an assignment of traffic to the routes such that for any given evacuation/reception pair:

1. all evacuees from the evacuation county to the reception county are assigned to one of the routes connecting the population centroids of the two counties.

2. all routes assigned traffic are equivalent in terms of average total transit time. Total transit time consists of actual travel time from origin to destination plus the length of the average delay imposed by the most congested link along the route.

3. all other possible routes have longer average total transit times than those which are assigned traffic by the model. (NOTE: See comments on setting the delay time termination limit.)

In brief, the algorithm contained in the IDA/BPT model selects routes and loads them in a way which approximates the loading which would result if evacuees were aware of the travel and delay times occurring on the network and were free to choose their own routes.

Normally, the U.S. highway system is uncongested except for certain links at well-known hours, i.e., the George Washington Bridge at rush hour and U.S. Route 50 between Washington and [illegible] Sunday afternoons during the summer. However, a crisis [illegible] would place such extraordinary demand [illegible]

congestion of major outbound highways would become the rule rather than the exception. This fact has two important implications for evacuation studies and plans. First, the technical characteristics associated with highway usage such as average speed and lane capacity can be expected to degrade and should be somewhat influenced by traffic control during an evacuation. Second, roundabout routes which would ordinarily be of little interest become important as alternatives to the heavily congested shortest routes.

The IDA/BPT model allows users to stipulate the major performance parameters of the highway system during an evacuation. These performance parameters are:

1. Vehicles/lane/hour for four highway categories: Class 1-3: Interstates and other 4-lane limited access roads, Class 4: Primary unlimited access 4-lane highways, Class 5: Primary unlimited access 2-lane highways, Class 6-7: All other roads.

2. Average speeds of movement in miles/hour for the same four highway categories.

3. Traffic control; three options are available: normal two-way traffic, one-way outbound traffic on congested links and, variable lanes control in which the traffic and capacity in both directions along a segment is pooled.

4. Average number of passengers per vehicle. The number of passengers per vehicle is used to convert evacuees to vehicles along routes. Normally, the number of occupants per vehicle is low, between one and two. However, enforced car pooling, intensive busing and the fact that families would typically evacuate as a unit should raise the average during an evacuation.

5. Normal evacuation time in hours. It would take time to effect an evacuation even if the highway system imposed no additional delays. Evacuees must be informed that an evacuation is underway, they must assemble with their families, do a necessarily minimal mount of preparation and then begin the evacuation by travelling on local roads to the major arteries of the highway system. The time it would take for the last evacuees to reach the highway system and begin moving outbound is the nominal

evacuation time. Half the nominal evacuation time is the average delay encountered by evacuees just reaching the regional transportation network.

Formally, a route is defined as a sequence of links which begins at the population centroid of an evacuation county and ends at the centroid of a reception county. The total transit time for a route is composed of two parts as follows:

1. Average travel time: the total time required to travel the route computed as the sum of the times required to cross each link at the speed established for the links by the model user.

2. Average delay time: one-half the lessor of the nominal evacuation time or the length of the delay imposed by the most congested link on the route. The delay imposed by a link is computed from the formula:

$$\text{Average delay in hours} = \frac{\text{number of evacuees traversing the link/passengers per vehicle}}{\text{vehicles per lane per hour x number of available lanes}}$$

The number of evacuees traversing a link is the sum of all evacuees assigned to routes which include the link (in both directions for variable lanes).

The route selection and loading algorithm is an iterative process in which route generation and network loading are alternated until no new routes can be found to improve the solution.

Step 1 - Initialization; all links on the regional transportation network are unblocked and may be included in routes. The list of routes is empty.

Step 2 - Route generation; the shortest route following an unblocked sequence of links is generated for each origin/destination pair of county centroids in the relocation plan. The method used to generate the best route from an evacuation county to a reception county is described below. A route is added to the route list if it does not duplicate a route already on the list and its transit time is shorter than the transit times of the routes already on the list for the same origin/destination pair.

Step 3 - Route loading; if no new routes are added to the route list in Step 2, the algorithm terminates. Otherwise, loadings for the new list of routes are computed using an iterative method for assigning traffic to a given set of

routes. The iterative method is described below. It converges fairly rapidly on a route loading which equalizes total travel times for all routes connecting the same origin/destination pairs. (If Step 3 is being executed for the first time, then the route loading is computed simply by assigning the evacuees for each origin/destination pair to the single route on the route list for that pair.)

Step 4 - Link blocking; the network is scanned for the unblocked link with the longest average delay time implied by the route loadings of Step 3. This link and all other links with comparable delay times are blocked. In practice all links with delay times of 90 percent or more of the longest average delay time are blocked. Blocking a link removes the link from the network only for the purpose of generating routes in Step 2. Blocking links has the effect of forcing the route generator to find link sequences which avoid those parts of the network which will cause delays during an evacuation.

Step 5 - Link list editing; if the longest average delay time found in Step 4 is less than a user-specified delay time termination limit, the algorithm terminates. Otherwise, the link list is edited by deleting unloaded or highly loaded routes with transit times which significantly exceed the transit times on loaded routes between the same origin/destination pair. The algorithm then returns to Step 2.

Routes are generated in Step 2 by applying an efficiently programmed version of the well-known Ford-Fulkerson method for finding the shortest route between two points along an uncapacitated network. The algorithm is more-than-adequately described in many operations research textbooks, for example, Principles of Operations Research by Harvey M. Wagner. (2nd edition, 1975, Prentice-Hall, Englewood Cliffs, N.J.) Basically, there are two phases to the computations. First, the shortest time to the destination node is determined for every point on the network. These times are then used in the second phase of the algorithm which is to determine the actual shortest route from any given origin to the destination.

The efficient programming of the algorithm is made possible by the presorting of the network links described earlier. This device for speeding computations was developed by BPT in a previous project for the

Department of Transportation of the State of Michigan. The presorted network simplifies the computations in both phases of the Ford-Fulkerson method by allowing the link list to be processed sequentially in segments.

In applying the Ford-Fulkerson method to generate routes in Step 2, the usual computational roles of the origin and destination are reversed. Times are computed from every point on the network to each evacuation county and routes are generated as though evacuees were moving from reception counties to evacuation counties. Since the network is symmetric, routes generated in this way are identical when the link sequence is inverted to those which would be generated if origins and destinations were not reversed. However, the reversal of the origins and destinations speeds computations since the first phase of the Ford-Fulkerson method is performed once for each evacuation county rather than once for each reception county. Ordinarily, there are far few evacuation counties than reception counties.

Route loading is performed in Step 3 of the algorithm by employing a simple iterative process. The process begins with the route loading from the previous execution of Step 3. Transit times for each route on the route list are computed using this initial loading. The route with the shortest transit time for each origin/destination pair is determined and a provisional network loading is constructed by assigning all of the evacuees for each origin/destination pair to the route with the shortest transit time. A new network loading is now obtained by forming a weighted average of the original network loading and the provisional network loading.

The process is now repeated with the new network loading replacing the network loading used to initiate Step 3. A new provisional loading

is constructed, a new weighted average is formed, and the new network loading is used to initiate another cycle of the process.

The process is continued for a fixed number of iterations. The weights which are used to form the weighted average are a function of the number of iterations. Let N be the number of iterations, then the weight applied to the provisional loading at iteration N is given by $W = 2/(N + 19)$ and the weight for the original loading is $1-W$. One hundred iterations are performed for each execution of Step 3. At the termination of the route selection and loading algorithm an additional four hundred iterations are performed to refine the final network loading.

The overall route selection and loading algorithm terminates if either one of two conditions exist. These are:

1. In Step 1, if the route generator fails to find any new routes to add to the existing route list. After several iterations through Step 4 the regional highway network tends to get reduced and disconnected. At some point so many links may be blocked that there exist no new routes meeting the criteria for inclusion on the route list in Step 1.

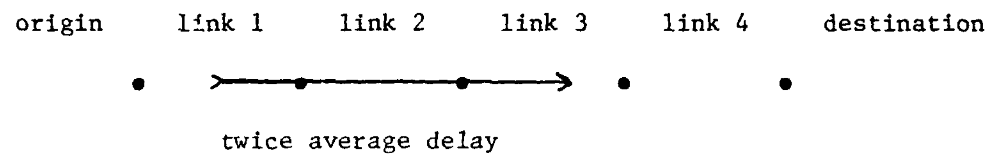
2. In Step 4, if the delay times on all of the remaining unblocked links in the network are less than the delay time termination limit. If the delay time termination limit is set less than or equal to half the nominal delay time then the algorithm will not stop until there are no more routes with longer average total transit times than those which are assigned traffic by the model. If the delay time termination limit is set higher than half the nominal delay time then the algorithm will terminate earlier with fewer routes. However, since the algorithm generates the best routes first there is frequently little to be gained by carrying computations to the point where every possible route has been examined. Usually, a good computational strategy is to set the delay time termination limit above half the nominal delay time but at a level which is still small in comparison to the delays likely to be encountered by evacuees on the most congested links of the network.

1.4 The Evacuation Simulator

The IDA/BPT model enables users to perform a computer simulation of an evacuation conducted according to a previously generated set of routes and route loadings. The simulation provides a picture of the progress of the crisis relocation at intervals of 2, 4, 6, 8, 12, 16, 20, 24, 32, 40, 48, 60, 72, and 84 hours after the start of the evacuation.

The simulation is performed route by route by determining the location of evacuees at each of the elapsed times given above. Evacuees are assumed to embark on each route in a steady stream commencing at time zero and lasting for twice the length of the average delay time for the route. The number of evacuees embarking per hour is the total number of evacuees assigned to the route by the route loading algorithm divided by twice the average delay time. The rate at which vehicles are fed onto the route is obtained by dividing the number of evacuees per hour by the average number of passengers per vehicle. In effect the delay which attaches to the use of a route is imposed on evacuees at the start of the route and not at the location of the most congested link which would actually be responsible for the delay.

The stream of evacuees using a particular route is of a fixed length in time and volume in vehicles per hour. As this stream proceeds out over the route towards its destination in a reception county the links along the route are successively entered, covered and exited by the stream of vehicles. The situation for a typical time in mid-evacuation is shown below. The arrow represents the stream of vehicles using the route. Its



progress along the route is governed by the speeds of movement on the sequence of links that form the route. When the stream completely covers a link, such as line 2, the volume of the stream is added to the traffic using the link. Where a link is only partly covered, such as links 1 and 3, a proportion of the volume equal to the fraction of the link which is covered by the stream, is added to traffic on the link. A record is also kept of the numbers of evacuees not yet departed from the evacuation county and already arrived at the reception county.

The status of the crisis relocation at each interval of time is summarized for model users in a series of tables which display:

- The status of all evacuees as at risk (unevacuated), en route or at distination.
- The distribution of departures by evacuation counties.
- The distribution of arrivals by reception counties.
- The distribution of traffic on the regional highway network.

2.0 User's Guide to the Computer Program

The IDA/BPT crisis relocation model has been programmed in FORTRAN and made available, together with the data files comprising its data base, on FEMA's Univac 1108 computer.

All of the model's source data and source programs are available as public files on the Univac 1108. Procedure files which may be added to the run stream to compile, assemble and execute the source programs are listed in the appendix.

The computer program is designed for interactive usage from a suitable computer terminal signed on to the Univac 1108 in the demand processing mode. A suitable terminal should have a BAUD rate of 300 or greater and be capable of printing single lines of 132 characters. After signon, users should set the line length to 132 characters with an @@TTY or @@DCT command. FEMA users may run the IDA/BPT computer program by adding three prepared files of commands to the run stream with the commands:

```
@@ADD BPT * EXECUTE. COMPILE
@@ADD BPT * EXECUTE. ASSEMBLE
@@ADD BPT * EXECUTE. RUN
```

The commands must be executed in the order given. The first command compiles the ASCII FORTRAN source code. The relocatable object code is stored in a temporary file named OBJECT. The second command assembles the relocatable object code in an element named OBJECT. MAIN. The third command links the source data files to the channels 8, 9 and 10; links channel 7 to a temporary file named "ROUTES" and links channels 11 through 20 to temporary files named FILE11, FILE12, etc. which can be

conveniently referenced by their channel numbers. The program is then run.

We have attempted to make the operation of the model as self-evident and forgiving to a terminal user as possible. Thus, users are always prompted with an appropriate question or request at all points where the program requires user-supplied information. In addition, a sufficient amount of terminal output is supplied to enable users to verify input values and to confirm the completion of major computational segments.

2.1 Master Control Sequence

Subject to several sequencing rules, the order in which the major components of the IDA/BPT model are exercised is under the control of the user. The computer program always begins by reproducing the following listing of control options at the terminal:

0 - Repeat List of Control Options
1 - Input/Compute Crisis Relocation Plan
2 - Run Route Finding/Loading Algorithm
3 - Simulate the Evacuation
4 - Assemble Network from Source Files
5 - Read Stored Network
6 - Save Network
7 - Reassign Input Channel for Parameter Values
8 - Reassign Output Channel for Summary Tables
9 - Reassign Output Channel for Route Listing
99 - Terminate Program

After execution of major program segments, the program always returns to the master control sequence with the following printed request:

INPUT CONTROL OPTION NUMBER

The user's response at the terminal determines the next major program operation subject to the following sequencing restrictions:

1. Options 1 and 6 cannot be selected until after either Option 4 or 5 has been executed.

2. Option 2 cannot be selected until after Option 1 has been executed and a crisis relocation plan input or computed.

3. Option 3 cannot be selected until after Option 2 has been executed and a route loading has been computed.

Since exercising control options often causes the loss or destruction of internally stored computational results, the program requires the verification of control option numbers with the request:

CONTROL OPTION n TYPE "OK" TO EXECUTE

The response "OK" leads directly to execution of the option; any other response recycle the master control sequence.

2.2 Input/Output Channel Options

The program receives parameter values, prints summary tables following most major computational segments and prints detailed listings of routes on completion of the route finding/loading algorithm. Initially, parameter values are input via the terminal (channel 5), summary tables are printed at the terminal (channel 6) and route listings are sent to a temporary file named "ROUTES" which is attached to the channel 7 and can be referenced by users as "7."

These assignments can be altered by selecting Options 7, 8 or 9. Following selection of each of these options, a request for a channel number is printed at the terminal:

INPUT NEW CHANNEL NUMBER (5 or 6 = TERMINAL)

Assignments of new channel numbers must obey the following rules:

1. Parameter values may be input through channel 5 and channels 11 to 20.

2. Summary tables and route listings may be output through channel 6 and channels 11 to 20. The route listings may also be output through channel 7.

3. Different channels must be used for parameter values, summary tables and route listings.

If a channel other than 6 (the terminal) is designated for the summary tables, copies of the very short tables which are printed at the terminal are also output through the summary table channel. Summary tables which are output through channels other than 6 are also numbered. The numbering system follows the numbering of the control options. Following is a complete list of the tables produced by the program:

2.3 Network Assembly, Storage and Retrieval

Control Options 4, 5 and 6 provide users with the ability to assemble regional transportation networks from the source data files, save assembled networks and retrieve previously-saved networks.

Under Option 4 regional networks of up to 10 states can be assembled from the source files comprising the model's data base. The size of the regional network is limited to no more than 500 nodes and 2,000 one-way links. This is sufficient to accommodate most regional networks of interest and the limits can readily be expanded if necessary.

To assemble a regional network, the user must specify the number of states to be included in the network and the FIPS numbers for the states in response to the requests:

INPUT THE NUMBER OF STATES IN THE REGION

and

INPUT n STATE NUMBERS

A directory of states listed by FIPS number is displayed in the table on the following page. The state's FEMA region number is also shown as an aid to users. The computer program echos the FIPS numbers and names of states to be included in an assembled regional network. Users must verify the list of included states by replying "OK" to the request:

TYPE "OK" TO ASSEMBLE NETWORK

As nodes and links are assembled for each state from the Node File and the Link File, a short message is printed at the terminal. If more than 500 nodes or 2,000 links are found, an error message is printed and the network assembly is aborted. Occasionally, a link is read with

TABLE: State Directory

FIPS No.	State/District Name	FEMA Region	FIPS No.	State/District Name	FEMA Region
1	Alabama	4	29	Missouri	7
2	Alaska	10	30	Montana	8
3			31	Nebraska	7
4	Arizona	9	32	Nevada	9
5	Arkansas	6	33	New Hampshire	1
6	California	9	34	New Jersey	2
7			35	New Mexico	6
8	Colorado	8	36	New York	2
9	Connecticut	1	37	North Carolina	4
10	Delaware	3	38	North Dakota	8
11	Dist. of Columbia	3	39	Ohio	5
12	Florida	4	40	Oklahoma	6
13	Georgia	4	41	Oregon	10
14	Guam	9	42	Pennsylvania	3
15	Hawaii	9	43	Puerto Rico	2
16	Idaho	10	44	Rhode Island	1
17	Illinois	5	45	South Carolina	4
18	Indiana	5	46	South Dakota	8
19	Iowa	7	47	Tennesee	4
20	Kansas	7	48	Texas	6
21	Kentucky	4	49	Utah	8
22	Louisiana	6	50	Vermont	1
23	Maine	1	51	Virginia	3
24	Maryland	3	52	Virgin Islands	2
25	Massachusetts	1	53	Washington	10
26	Michigan	5	54	West Virginia	3
27	Minnesota	5	55	Wisconsin	5
28	Mississippi	4	56	Wyoming	8

endpoints which cannot be matched to any location on the node list. When this occurs a one-line message is printed and the network assembly is allowed to continue. When the data assembly is completed the total numbers of nodes and links in the regional network are printed and the network is sorted.

Up to ten regional networks can be sorted in ready-to-use form on files attached to channels 11 through 20. Option 6 stores an assembled network and Option 5 retrieves one which was previously stored. Users must supply the program with a channel number. When a network is retrieved, the program lists the states included in the region and the number of nodes and links in the network.

Following the assembly or retrieval of a regional network, users are given an opportunity to list the information pertaining to the population centroids in the region. The response "YES" or just "Y" to the question:

LIST THE POPULATION CENTROIDS (YES OR NO)?

results in the production of Table 4.1 presenting the data from the node file for each centroid.

2.4 The Crisis Relocation Plan

Control Option 1 directs the program to obtain a new crisis relocation plan either directly from the user or by constructing and solving a linear program (the transportation problem) according to directions. A simplified flow chart for this segment of the program is presented on the next page.

The interactive sequence begins with:

INPUT EVACUATION PLAN (YES OR NO)?

To directly input an evacuation plan a user responds "YES" or just "Y." Any other response is interpreted as a "NO." If the response is "YES," the program then requests from the user a list of numbers, three numbers for each evacuation/reception county pair in the crisis relocation plan:

FOR EACH PAIR INPUT: EVACUATION COUNTY NO.,
RECEPTION COUNTY NO., NUMBER OF PEOPLE

The three numbers for each pair must be typed on a single line and separated by commas. The county numbers are 5-digit state/county FIPS codes. Example: The line

26163, 26115, 100000

calls for the relocation of 100,000 people from Wayne County (26163) Michigan to Monroe County (26115). The program echo checks information as it is input. If a nonpositive number is input for the evacuation county, the result is to delete the immediately preceding evacuation/reception pair. To terminate the input sequence for the crisis relocation plan, the user types the line:

999, 999, 999

The program prints the whole plan and returns to the master control sequence.

If the crisis relocation plan is not input directly, the program computes one by constructing and solving the transportation problem described in 1.2. First, users are given the opportunity to directly input the evacuation counties and the number of evacuees from each county:

SPECIFY EVACUATION COUNTIES (YES OR NO)?

If the user answers "YES" or "Y," the program interrogates the user as follows:

FOR EACH EVACUATION COUNTY INPUT:

COUNTY NO., NUMBER OF PEOPLE

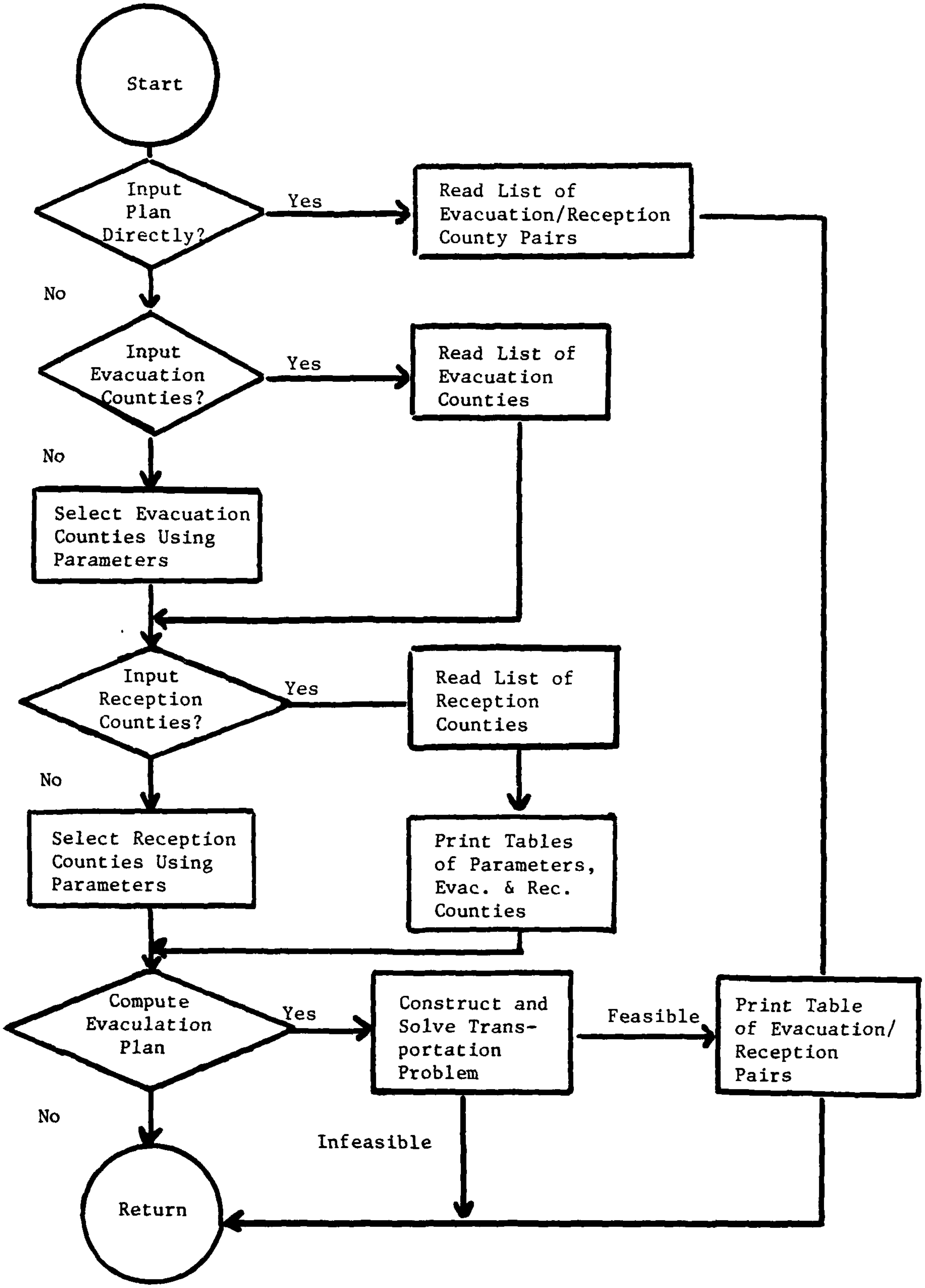
For each evacuation county the user types the county's 5-digit FIPS code and the number of evacuees from the county separated by a comma. For example:

26163, 2000000

instructs the program to treat Wayne County (26163) as an evacuation county with 2,000,000 residents to be relocated. The data is echo checked on input, a nonpositive county number deletes the previously input evacuation county, and the input sequence is terminated by typing the line:

999, 999

If the user does not directly specify the evacuation counties, then they will be indirectly specified by a set of controls and parameter values which must be provided by the user in response to a series of information requests appearing at the terminal:


Start
Input Plan Directly?
Yes
Read List of Evacuation/Reception County Pairs
No
Input Evacuation Counties?
Yes
Read List of Evacuation Counties
No
Select Evacuation Counties Using Parameters
Input Reception Counties?
Yes
Read List of Reception Counties
No
Select Reception Counties Using Parameters
Print Tables of Parameters, Evac. & Rec. Counties
Compute Evaculation Plan
Yes
Construct and Solve Trans- portation Problem
Feasible
Print Table of Evacuation/ Reception Pairs
No
Infeasible
Return

INPUT VULNERABILITY GROUP CODE (1 TO 4)

The user supplies the first digit of FEMA's crisis relocation county classification system. All counties with a first digit which is less than the supplied parameter value (except for A counties) are considered evacuation counties, i.e., the response "3" has the effect of treating all B and C counties as evacuation counties.

INPUT MINIMUM PERCENT TO BE EVACUATED

The user supplies a number in the range 0-100. This percentage is applied to each evacuation county's 1980 population to determine the minimum number of evacuees.

EVACUATE COUNTERFORCE TARGETS (YES OR NO)?

If the user responds "YES" or "Y" then all counties which have significant counterforce targets, as indicated by the second digit of the FEMA classification code, are added to the list of evacuation counties. All of the populations of counties with counterforce targets are evacuated.

INPUT POST EVACUATION MAXIMUM DENSITY IN
EVACUATED COUNTIES IN PEOPLE/SQUARE MILE

The number supplied is compared to the normal population density of each evacuation county. If the normal density exceeds the maximum, then the number of evacuees required to reach the maximum density is computed. This figure is then compared to the number of evacuees previously computed using the minimum percentage. The larger of the two numbers is retained as the number of eva uees from the county.

A similar sequence is followed for reception counties and their capacity to hold evacuees. To directly input reception counties and capacities the users answers "YES" or "Y" to:

SPECIFY THE RECEPTION COUNTIES (YES OR NO)?

For each reception county, the user supplies the county's 5-digit FIPS code and the number of places for evacuees in the county. For example:

26115, 100000

indicates that Monroe County (26115) is a reception county capable of accommodating 100,000 evacuees. The data is echo checked on input, a nonpositive county number deletes the previously input evacuation county, and the input sequence is terminated by typing the line:

999, 999

If the reception counties are not specified, then a set of controls and parameter values are used to identify reception counties within the region.

INPUT MINIMUM, MAXIMUM PRE-EVACUATION RECEPTION AREA DENSITY IN PEOPLE/SQUARE MILE

Two numbers, separated by a comma, are typed at the terminal. The list of non-evacuation counties is then scanned for counties whose 1980 population density falls within the stipulated limits. Such counties are included on the list of reception counties. For example, the response:

20, 500

would limit the selection of reception counties to those with 1980 population densities between 20 and 500 people/square mile. The lower limit serves to exclude areas such as mountains and deserts which cannot sustain evacuees while the upper limit excludes counties which are densely populated but have not been selected for evacuation.

INPUT MINIMUM, MAXIMUM TRAVEL TIME IN HOURS X 100

The response to this request establishes a travel time band around each evacuation county. Travel times are measured along the fastest route at normal highway speeds. As the transportation problem described in 1.2

is constructed the travel times (t_{ij}) assigned to movements from evacuation counties (i) to reception counties (j) are the normal travel times between the counties. However, when these normal travel times fall outside the travel time band, the travel times are artificially increased by 1,000 hours. In effect, reception counties within the travel time bands of evacuation counties are filled before any use is made of reception counties which lie outside the time bands. For example, the values:

50, 400

establish a band from half an hour to four hours around each evacuation county. The program will relocate evacuees from an evacuation county to reception counties within this band until the reception capacity of these counties is expended before using any other reception counties. The lower limit (one-half hour) pushes evacuees beyond the immediate suburbs of most cities while the upper limit (four hours) holds evacuees within the range of a one-day round trip from their homes and places of work.

INPUT MAXIMUM RESIDENT POPULATION MULTIPLE X 100

The maximum resident population multiple is applied to each reception county's 1980 population to determine the number of evacuees which the county can accommodate. For instance, a response of "300" is interpreted to mean that reception counties can hold two evacuees for every pre-evacuation resident. Thus, the capacities of the reception counties would initially be set at two times each county's 1980 population.

INPUT POST EVACUATION MAXIMUM DENSITY IN
RECEPTION COUNTIES IN PEOPLE/SQUARE MILE

The area of each reception county is multiplied by the maximum density supplied by the user to obtain the maximum number of people which the

the county can hold following an evacuation. The 1980 population is then subtracted to yield the maximum number of evacuees. This maximum is compared to the reception capacity computed using the maximum resident population multiple and, if smaller, it becomes the county's reception capacity.

At this point in the program, all of the information required to formulate the transportation problem described in 1.2 has been input and processed. A short table is printed at the terminal displaying the total number of evacuation counties, evacuees, reception counties, reception capacity and the values of all parameters supplied by the user. The table listing is followed by the line:

TYPE "OK" TO COMPUTE EVACUATION PLAN

If the user responds with an "OK," a standard algorithm is applied to either solve the transportation problem or to determine that it is infeasible. A short message is printed at the terminal reporting the outcome of the attempt to solve the problem. Any response other than "OK" returns the program to the master control sequence without solving the transportation problem.

2.5 Route Selection and Loading

Control Option 2 results in the selection and loading of routes for a crisis relocation plan as described in 1.3. A simplified flow chart appears on the following page.

To select and load routes a certain amount of additional information about the operation of the highway network during an evacuation is needed. This information must be supplied by the user when requested by the program.

INPUT VEHICLES/LANE/HOUR FOR 1) LIMITED ACCESS, 2) PRIMARY 4-LANE, 3) PRIMARY 2-LANE, 4) SECONDARY HIGHWAYS

Four numbers are input giving the emergency carrying capacity in vehicles/lane/hour of four general classes of highways. The capacity of each link is found by multiplying the number of available lanes by the vehicles/lane/hour for the type of highway comprising the link. Example:

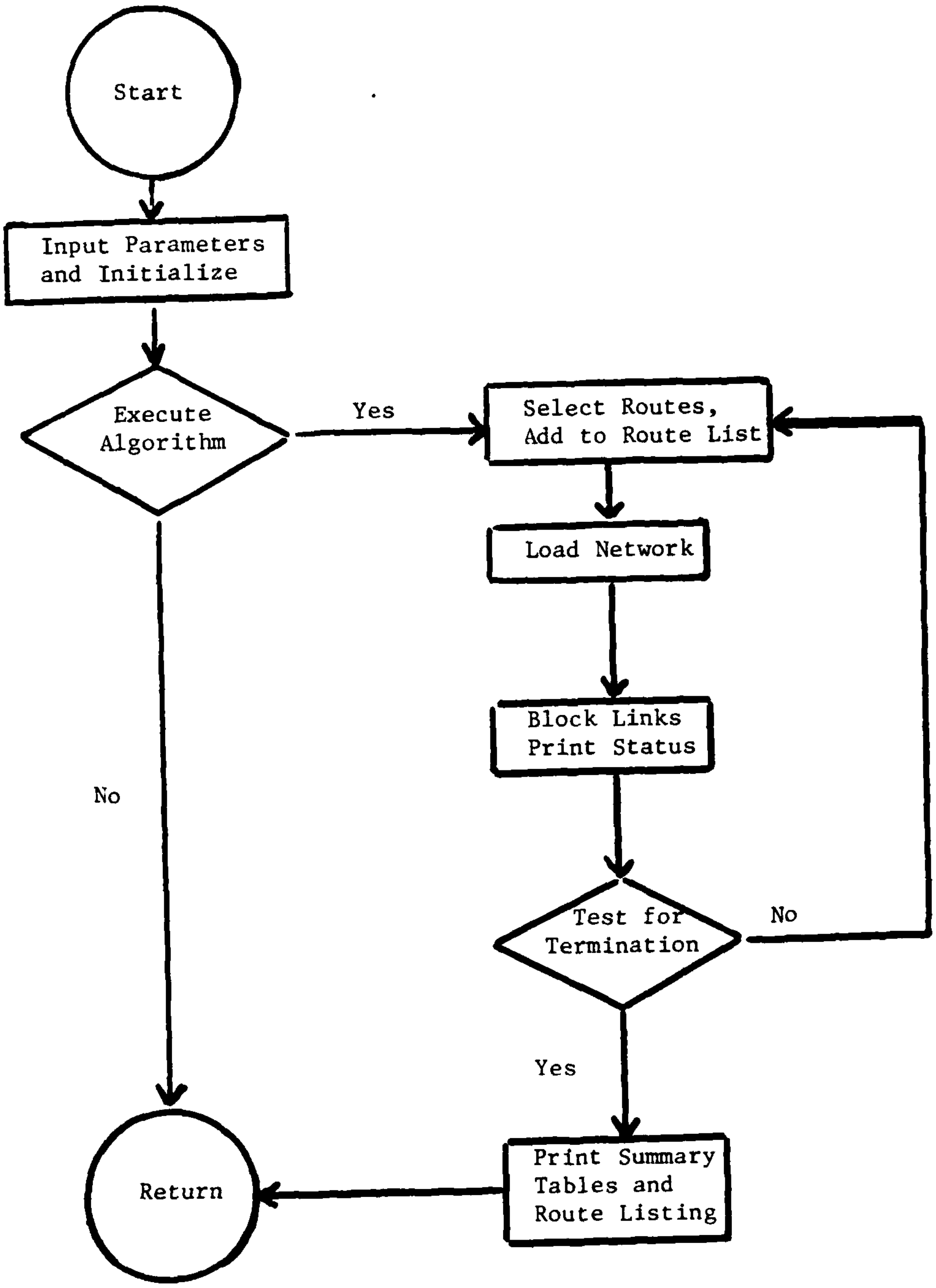
2000, 1500, 1400, 1200

Speeds of movement during an evacuation are input for the same highway classes in response to the following request:

INPUT AVERAGE SPEED IN MILES/HOUR FOR 1) LIMITED ACCESS, 2) PRIMARY 4-LANE, 3) PRIMARY 2-LANE, 4) SECONDARY HIGHWAYS

Normal nonevacuation speeds along the highway network are taken to be 55, 45, 40 and 30 miles per hour. Slower average speeds would likely prevail during an evacuation. For example:

40, 35, 35, 30


Start
Input Parameters and Initialize
Execute Algorithm
Yes
Select Routes, Add to Route List
Load Network
Block Links Print Status
Test for Termination
No
No
Yes
Print Summary Tables and Route Listing
Return

As discussed in 1.3 three options exist for controlling the use of highway lanes during an evacuation. One of these options must be selected by the user in response to:

INPUT HIGHWAY CONFIGURATION COPE 1) NORMAL,
2) ONE WAY, 3) VARIABLE LANES

The responses "1," "2" and "3" correspond to the three options described in 1.3.

INPUT PASSENGERS/VEHICLE X 100

The user-supplied number is needed to convert evacuees to vehicles along routes.

INPUT NOMINAL EVACUATION TIME IN HOURS X 100

Half the nominal evacuation time is imposed as an initial minimum average delay for all evacuees on all routes.

INPUT DELAY TIME TERMINATION LIMIT IN HOURS X 100

The route selection and loading algorithm terminates if the delay times on unblocked links are all less than the termination limit supplied by the user or half the nominal evacuation time.

A short table is printed at the terminal echoing the input parameter values followed by:

TYPE "OK" TO GENERATE ROUTES

The response "OK" is immediately followed by execution of the route selection and loading algorithm described in 1.3. Any other response returns the program to the master control sequence. As the algorithm proceeds a short listing appears at the terminal describing the progress of the computations. The listing describes the status of the link list after each pass and the links which are blocked prior to the next pass through the Ford-Fulkerson route selection routines.

2.6 Evacuation Simulation

Control Option 3 directs the program to simulate an evacuation along the regional highway network according to a previously computed set of routes and loadings. No additional input is required from the user. At the conclusion of the simulation, a short table is printed at the terminal showing the percentile distribution of evacuees as at risk (unevacuated), en route, or at their destination.

3.0 Sample Run

A sample run using FEMA's UNIVAC 1108 computer illustrates the interactive usage of the IDA/BPT model and provides examples of the variety of tables that can be generated by model users. There are three parts to the sample run:

1. The on-line (terminal) input/output stream.
2. Summary tables output through channel 20.
3. Route listings output through channel 19.

3.1 Terminal Input/Output Stream

The sample run is a straightforward application of the model to a small but typical problem, the evacuation of the major population, industry and military centers of New England. The terminal listing has been annotated to show the major elements of the computations:

1. The control options are listed as the program begins execution.

2. Route listings are routed to channel 19 which is linked to the file FILE 19.

3. Summary tables are routed to channel 20 which is linked to the file FILE 20.

4a. The New England regional transportation network is retrieved in preprocessed form through channel 11. Previously it had been stored on FILE 11, or,

4b. The New England network is assembled from the transportation network data base.

5. Table 4.0 is printed.

6. The controls and parameter values for the crisis relocation planning submodel are input.

7. Table 1.0 is printed; the transportation problem is solved.

8. The controls and parameter values for the route selection and loading submodel are input.

9. Table 2.0 is printed; the route selection and loading algorithm is begun.

10. Table 2.1 is printed as the algorithm progresses. Each line of the table shows a link to be blocked at the next iteration of the route selection procedure. Also shown is the size of the route list after each pass.

11. The evacuation is simulated; Table 3.0 is printed.

12. End.

1
```
LIST OF CONTROL OPTIONS
NO.  CONTROL OPTION
 0   REPEAT LIST OF CONTROL OPTIONS
 1   INPUT/COMPUTE CRISIS RELOCATION PLAN
 2   RUN ROUTE FINDING/LOADING ALGORITHM
 3   SIMULATE THE EVACUATION
 4   ASSEMBLE NETWORK FROM DATA FILES
 5   READ STORED NETWORK
 6   SAVE GENERATED NETWORK
 7   REASSIGN INPUT CHANNEL FOR PARAMETER VALUES
 8   REASSIGN OUTPUT CHANNEL FOR SUMMARY TABLES
 9   REASSIGN OUTPUT CHANNEL FOR ROUTE LISTING
99   TERMINATE PROGRAM
```

2
```
INPUT CONTROL OPTION NUMBER
9
CONTROL OPTION  9 TYPE "OK" TO EXECUTE
OK
INPUT NEW CHANNEL NUMBER (6=TERMINAL)
19
```

3
```
INPUT CONTROL OPTION NUMBER
8
CONTROL OPTION  8 TYPE "OK" TO EXECUTE
OK
INPUT NEW CHANNEL NUMBER (6=TERMINAL)
20
```

4a
```
INPUT CONTROL OPTION NUMBER
5
CONTROL OPTION  5 TYPE "OK" TO EXECUTE
OK
ASSIGN INPUT CHANNEL FOR SAVED NETWORK
11
```

5
```
NUMBER  STATE NAME
   9    CONNECTICUT
  23    MAINE
  25    MASSACHUSETTS
  33    NEW HAMPSHIRE
  44    RHODE ISLAND
  50    VERMONT

NUMBER OF NETWORK NODES        170
NUMBER OF NETWORK LINKS        788

LIST THE POPULATION CENTROIDS (YES OR NO)?
YES
```

4b
```
INPUT CONTROL OPTION NUMBER
4
CONTROL OPTION  4 TYPE "OK" TO EXECUTE
OK

INPUT THE NUMBER OF STATES IN THE REGION (UP TO 10)
6
INPUT  6 STATE NUMBERS
9,23,25,33,44,50
```

5
```
NUMBER  STATE NAME
   9    CONNECTICUT
  23    MAINE
  25    MASSACHUSETTS
  33    NEW HAMPSHIRE
  44    RHODE ISLAND
  50    VERMONT

TYPE "OK" TO ASSEMBLE NETWORK
OK
READING  37 NODES FOR STATE  9
READING  25 NODES FOR STATE 23
READING  39 NODES FOR STATE 25
READING  33 NODES FOR STATE 33
READING  15 NODES FOR STATE 44
READING  21 NODES FOR STATE 50
READING 200 LINKS FOR STATE  9
READING 114 LINKS FOR STATE 23
READING 224 LINKS FOR STATE 25
READING 184 LINKS FOR STATE 33
READING  76 LINKS FOR STATE 44
READING 118 LINKS FOR STATE 50

NUMBER OF NETWORK NODES        170
NUMBER OF NETWORK LINKS        788
```

6
```
INPUT CONTROL OPTION NUMBER
1
CONTROL OPTION  1 TYPE "OK" TO EXECUTE
OK

INPUT EVACUATION PLAN (YES OR NO)?
NO
SPECIFY EVACUATION COUNTIES (YES OR NO)?
NO
INPUT VULNERABILITY GROUP CODE (1 TO 4)

INPUT MINIMUM PERCENT TO BE EVACUATED

EVACUATE COUNTERFORCE TARGETS (YES OR NO)?
YES
INPUT POST EVACUATION MAXIMUM DENSITY IN EVACUATED COUNTIES IN PEOPLE/SQ. MILE
500
SPECIFY RECEPTION COUNTIES (YES OR NO)?
NO
INPUT MINIMUM, MAXIMUM PRE-EVACUATION RECEPTION AREA DENSITY IN PEOPLE/SQ. MILE
10,300
INPUT MINIMUM, MAXIMUM TRAVEL TIME IN HOURS X 100
50,800
INPUT MAXIMUM RESIDENT POPULATION MULTIPLE X 100
300
INPUT POST EVACUATION MAXIMUM DENSITY IN RECEPTION COUNTIES IN PEOPLE/SQ. MILE
500
```

7
```
NUMBER OF EVACUATED COUNTIES  11     EVACUATED POPULATION       2639506.
NUMBER OF RECEPTION COUNTIES  41     RECEPTION AREA CAPACITY    4251722.
VULNERABILITY GROUP CODE:  3
MINIMUM EVACUATED POPULATION:     90. PERCENT
COUNTERFORCE TARGETS ARE EVACUATED
MINIMUM RECEPTION AREA DENSITY:    10. PEOPLE/SQ MILE
MAXIMUM RECEPTION AREA DENSITY:   300. PEOPLE/SQ MILE
MINIMUM TRAVEL TIME TO RECEPTION AREAS:    .50 HOURS
MAXIMUM TRAVEL TIME TO RECEPTION AREAS:   8.00 HOURS
MAXIMUM RESIDENT POPULATION MULTIPLE:   3.00
POST EVACUATION MAXIMUM DENSITY IN EVACUATED AREAS:   500.
POST EVACUATION MAXIMUM DENSITY IN RECEPTION AREAS:   500.

TYPE "OK" TO COMPUTE EVACUATION PLAN
OK

EVACUATION PROBLEM IS FEASIBLE
NUMBER OF EVACUATION/RECEPTION COUNTY PAIRS  29
```

8
```
INPUT CONTROL OPTION NUMBER
2
CONTROL OPTION  2 TYPE "OK" TO EXECUTE
OK

INPUT VEHICLES/LANE/HOUR FOR 1)LIMITED ACCESS, 2)PRIMARY 4-LANE, 3)PRIMARY 2-LANE, 4)SECONDARY HIGHWAYS
2000,1600,1400,1200
INPUT AVERAGE SPEED IN MILES/HOUR FOR 1)LIMITED ACCESS, 2)PRIMARY 4-LANE, 3)PRIMARY 2-LANE, 4)SECONDARY HIGHWAYS
45,40,35,30
INPUT HIGHWAY CONFIGURATION CODE 1)NORMAL, 2)ONE WAY, 3)VARIABLE LANES
2
INPUT PASSENGERS/VEHICLE X 100
400
INPUT NOMINAL EVACUATION TIME IN HOURS X 100
800
INPUT DELAY TIME TERMINATION LIMIT IN HOURS X 100
600
```

9
```
HIGHWAY CLASS   VCLS/LANE/HR  MILES/HOUR
LIMITED ACCESS       2000.         45.
PRIMARY 4-LANE       1600.         40.
PRIMARY 2-LANE       1400.         35.
SECONDARY            1200.         30.
HIGHWAY CONFIGURATION: ONE WAY OUTBOUND TRAFFIC
AVERAGE PASSENGERS PER VEHICLE:  4.00
NOMINAL EVACUATION TIME:  8.00 HOURS
DELAY TIME TERMINATION LIMIT:  6.00 HOURS

TYPE "OK" TO GENERATE ROUTES
OK
```

10

PASS	ROUTES	CAPACITY	VEHICLES	DELAY	FROM	COUNTY	TO	COUNTY	ROUTE NAME
1	29	1400.	78058.	27.88	AVON	HARTFORD	WINSTEAD	LITCHFIELD	U.S. ROUTE 44
		1400.	78058.	27.88	HARTFORD	HARTFORD	AVON	HARTFORD	U.S. ROUTE 44
		1400.	72555.	25.91	LEE	BERKSHIRE	PITTSFIELD	BERKSHIRE	U.S. ROUTE 7
2	33	4000.	147142.	13.33	MANCHESTER	HILLSBOROUGH	CONCORD	MERRIMACK	INTERSTATE 93
3	35	1400.	41422.	14.79	SOUTH FOSTER	PROVIDENCE	DANIELSON	WINDHAM	U.S. ROUTE 6
		1400.	41422.	14.79	JOHNSTON	PROVIDENCE	SOUTH FOSTER	PROVIDENCE	U.S. ROUTE 6
4	35	1400.	31425.	11.22	SANFORD	YORK	PORTLAND	CUMBERLAND	U.S. ROUTE 202
		1400.	31422.	11.53	BELCHERTOWN	HAMPSHIRE	NORTHHAMPTON	HAMPSHIRE	STATE ROAD 9
		4000.	49729.	12.34	BOSTON	SUFFOLK PSD	LAWRENCE	ESSEX	INTERSTATE 93
		1400.	[illegible]	11.46	SPRINGFIELD	HAMPDEN	CHICOPEE	HAMPDEN	INTERSTATE 91
		1400.	31422.	11.53	WORCHESTER	WORCESTER	BELCHERTOWN	HAMPSHIRE	STATE ROAD 9
		4000.	49729.	12.34	LAWRENCE	ESSEX	MANCHESTER	HILLSBOROUGH	INTERSTATE 93
5	42	1400.	29173.	10.42	ORANGE	FRANKLIN	GREENFIELD	FRANKLIN	STATE ROAD 2
		4000.	78729.	9.84	SLATERSVILLE	PROVIDENCE	WORCHESTER	WORCESTER	STATE ROAD 146
		1400.	29173.	10.42	WORCHESTER	WORCESTER	ORANGE	FRANKLIN	STATE ROAD 122
		4000.	78729.	9.84	ESMOND	PROVIDENCE	ASTON	PROVIDENCE	INTERSTATE 295
		4000.	78729.	9.84	ASTON	PROVIDENCE	SLATERSVILLE	PROVIDENCE	STATE ROAD 146
6	41	4000.	73986.	9.25	BIDDLEFORD	YORK	PORTLAND	CUMBERLAND	INTERSTATE 95
		4000.	73986.	9.25	PORTSMOUTH	ROCKINGHAM	BIDDLEFORD	YORK	INTERSTATE 95
		1400.	24202.	8.64	NORTHHAMPTON	HAMPSHIRE	PITTSFIELD	BERKSHIRE	STATE ROAD 9
7	41	1400.	23294.	8.32	ASHFORD	WINDHAM	BOLTON	TOLLAND	U.S. ROUTE 44
		1400.	23294.	8.32	PUTNAM	WINDHAM	ASHFORD	WINDHAM	U.S. ROUTE 44
		1400.	23294.	8.32	CHEPACHET	PROVIDENCE	PUTNAM	WINDHAM	U.S. ROUTE 44
		1400.	21442.	7.66	NORTHFIELD	MERRIMACK	LACONIA	BELKNAP	U.S. ROUTE 3
		1400.	21524.	7.69	MANCHESTER	HILLSBOROUGH	CONCORD	MERRIMACK	U.S. ROUTE 3
		4000.	61121.	7.64	NASHUA	HILLSBOROUGH	MANCHESTER	HILLSBOROUGH	STATE ROAD 900
		1400.	23294.	8.32	ESMOND	PROVIDENCE	CHEPACHET	PROVIDENCE	U.S. ROUTE 44
8	44	4000.	57642.	7.21	MARLBORO	HARTFORD	HARTFORD	HARTFORD	STATE ROAD 2
		4000.	57642.	7.21	NORWICH	NEW LONDON	COLCHESTER	NEW LONDON	STATE ROAD 2
		1400.	20415.	7.29	MERIDAN	NEW HAVEN	MILLDALE	HARTFORD	STATE ROAD 66
		4000.	57642.	7.21	COLCHESTER	NEW LONDON	MARLBORO	HARTFORD	STATE ROAD 2
		4000.	56932.	7.12	BOSTON	SUFFOLK PSD	DANVERS	ESSEX	INTERSTATE 95
		4000.	58570.	7.32	CHICOPEE	HAMPDEN	NORTHHAMPTON	HAMPSHIRE	INTERSTATE 91
		4000.	58570.	7.32	SPRINGFIELD	HAMPDEN	CHICOPEE	HAMPDEN	U.S. ROUTE 5
		4000.	56932.	7.12	DANVERS	ESSEX	AMESBURY	ESSEX	INTERSTATE 95
		1200.	17135.	7.14	WICHENDON	WORCESTER	KEENE	CHESHIRE	STATE ROAD 12
		4000.	56932.	7.12	HAMPTON	ROCKINGHAM	PORTSMOUTH	ROCKINGHAM	INTERSTATE 95
		4000.	56932.	7.12	AMESBURY	ESSEX	HAMPTON	ROCKINGHAM	INTERSTATE 95
9	47	1400.	17135.	6.12	GARDNER	WORCESTER	WICHENDON	WORCESTER	STATE ROAD 140
		1400.	17135.	6.12	WORCHESTER	WORCESTER	GARDNER	WORCESTER	STATE ROAD 140
		1400.	18031.	6.44	NEWPORT	SULLIVAN	CLAREMONT	SULLIVAN	STATE ROAD 11
		4000.	51665.	6.46	CONCORD	MERRIMACK	NORTHFIELD	MERRIMACK	INTERSTATE 93
		1400.	18031.	6.44	NEW LONDON	MERRIMACK	NEWPORT	SULLIVAN	STATE ROAD 11
		1400.	18311.	6.54	NEWPORT	NEWPORT	SAUNDERSTOWN	WASHINGTON	STATE ROAD 138
10	47	4000.	44462.	5.56	TORRINGTON	LITCHFIELD	WINSTEAD	LITCHFIELD	STATE ROAD 8
		4000.	44462.	5.56	MILLDALE	HARTFORD	WATERBURY	NEW HAVEN	INTERSTATE 84
		4000.	44462.	5.56	WATERBURY	NEW HAVEN	THOMASTOWN	LITCHFIELD	STATE ROAD 8
		4000.	44462.	5.56	THOMASTOWN	LITCHFIELD	TORRINGTON	LITCHFIELD	STATE ROAD 8
		1200.	13923.	5.80	PETERBOROUGH	HILLSBOROUGH	KEENE	CHESHIRE	STATE ROAD 101
		1200.	13923.	5.80	NASHUA	HILLSBOROUGH	MILFORD	HILLSBOROUGH	STATE ROAD 102
		1200.	13260.	5.53	MANCHESTER	HILLSBOROUGH	HENNIKER	MERRIMACK	STATE ROAD 114
		1200.	13923.	5.80	MILFORD	HILLSBOROUGH	PETERBOROUGH	HILLSBOROUGH	STATE ROAD 101
		4000.	43545.	5.44	HOPKINTOWN	MERRIMACK	NEW LONDON	MERRIMACK	INTERSTATE 89
		1400.	14703.	5.25	BURLINGTON	CHITTENDEN	VERGENNES	ADDISON	U.S. ROUTE 7

11 INPUT CONTROL OPTION NUMBER
3
CONTROL OPTION 3 TYPE "OK" TO EXECUTE
OK

EVACUEES: 2639504.

ELAPSED HOURS:	2	4	6	8	12	16	20	24	32	40	48	60	72	84
PERCENTAGE OF EVACUEES AT RISK	79	59	38	18	0	0	0	0	0	0	0	0	0	0
PERCENTAGE OF EVACUEES EN ROUTE	15	17	17	17	4	0	0	0	0	0	0	0	0	0
PERCENTAGE OF EVACUEES AT DESTINATION	4	23	43	64	94	99	99	99	99	99	99	99	99	99

12 INPUT CONTROL OPTION NUMBER
99
TYPE "OK" TO TERMINATE
OK
PROGRAM ENDS

3.2 Summary Tables

The summary tables 1.0, 2.0, 2.1, 3.0 and 4.0 reproduce tables from the on-line input/output stream and are not duplicated below. All of the other summary tables from the sample run are shown below. Variable definitions are given in the notes accompanying each table.

Notes for Table 4.1

FIPS - five-digit state/county FIPS code
PLACE NAME - name of county center or principal city
COUNTY - county name
POPULATION - residents according to the 1980 U.S. Census
AREA - square miles of area
DENSITY - pre-evacuation people/square mile
FEMA - FEMA Countervalue code A, B, C or D
FEMA Counterforce flag X
blank field indicates population not at risk

Notes for Table 1.1

EVACUATION/RECEPTION COUNTY - county name
RESIDENTS - pre-evacuation population
AREA - square miles
DENSITY - pre-evacuation people/square mile
AT RISK POPULATION - number of evacuees
REC. CAPACITY (evacuation counties) - capacity of reception counties within preferred travel time band of the evacuation county
CRITERIA - criteria for determining capacity of reception county
REC. CAPACITY (evacuation counties) - capacity of reception county to accommodate additional population

Notes to Table 2.1

PAIR - pair number ordered by normal travel time
PEOPLE - number of evacuees
ORIGIN/DESTINATION - name f county center
COUNTY - county name
HOURS - hours from origin to destination at normal speeds along fastest route
MILES - length of fastest route
DENSITY - *post-evacuation density of the reception county*

Notes to Table 2.2

ROUTE - route list sequence number
PAIR - evacuation/reception pair number
EVACUEES - loading of the route
CITY - name of county center
COUNTY - county name
DISTANCE - length of route in miles
TRAVEL - average travel hours at evacuation speeds
DELAY - average delay hours
TOTAL - TRAVEL plus DELAY time

Notes to Tables 3.1 and 3.2

EVACUATION/RECEPTION COUNTY - county name
EVACUEE - number of people evacuated from or to the county
PERCENTAGE - percentage of evacuees departed from or arrived at the county at the elapsed hour shown

Notes to Table 3.3

FROM/TO - name of county center
ROUTE NAME - highway type and number
DISTANCE - length of the link in miles
SPEED - evacuation miles/hour
CAPACITY - evacuation vehicles/hour for all available lanes
PERCENTAGE - percentage of capacity in use for the evacuation plan at the elapsed hour shown

1TABLE 4.1

POPULATION CENTROID LIST

FIPS	PLACE NAME	COUNTY	POPULATION	AREA	DENSITY	FEMA
9001	DANBURY	FAIRFIELD	807143.	633.	1275.	C
9003	HARTFORD	HARTFORD	807766.	741.	[illegible]	D
9005	WINSTEAD	LITCHFIELD	1567[illegible].	938.	167.	
9007	OLD SAYBROOK	MIDDLESEX	129017.	374.	345.	
9009	NORTH HAVEN	NEW HAVEN	[illegible]	605.	[illegible]	C
9011	NORWICH	NEW LONDON	238409.	672.	355.	C X
9013	BOLTON	TOLLAND	114823.	415.	276.	
9015	DANIELSON	WINDHAM	92312.	516.	179.	
23001	LEWISTON	ANDROSCOGGIN	99657.	479.	208.	D
23003	HOULTON	AROOSTOOK	91331.	6805.	13.	D X
23005	PORTLAND	CUMBERLAND	215789.	881.	245.	D
23007	WILTON	FRANKLIN	27098.	1717.	16.	
23009	ELLSWORTH	HANCOCK	41781.	1542.	27.	
23011	AUGUSTA	KENNEBEC	109889.	865.	127.	
23013	ROCKLAND	KNOX	32941.	362.	91.	
23015	NEWCASTLE	LINCOLN	25691.	457.	56.	
23017	NEWRY	OXFORD	48968.	2085.	23.	
23019	BANGOR	PENOBSCOT	137015.	3408.	40.	D
23021	FOXCROFT	PISCATAQUIS	17634.	3948.	4.	
23023	BATH	SAGADAHOC	28795.	257.	112.	
23025	SKOWHEGAN	SOMERSET	45028.	3948.	11.	
23027	BELFAST	WALDO	28414.	734.	39.	
23029	MACHIAS	WASHINGTON	34963.	2553.	14.	D
23031	SANFORD	YORK	139666.	1000.	140.	D X
25001	SAGAMORE	BARNSTABLE	147925.	399.	371.	
25003	PITTSFIELD	BERKSHIRE	145110.	942.	154.	D
25005	TAUNTON	BRISTOL	474641.	556.	854.	D
25007	EDGARTOWN	DUKES	8942.	106.	84.	
25009	DANVERS	ESSEX	633632.	500.	1267.	D
25011	GREENFIELD	FRANKLIN	64317.	722.	89.	
25013	SPRINGFIELD	HAMPDEN	443018.	621.	713.	C X
25015	NORTHHAMPTON	HAMPSHIRE	138813.	537.	258.	
25017	LITTLETON	MIDDLESEX	1367034.	829.	1647.	D
25019	NANTUCKETT	NANTUCKET	5087.	46.	111.	D
25021	FRANKLIN	NORFOLK	606587.	398.	1524.	
25023	PLYMOUTH	PLYMOUTH	405437.	664.	611.	D
25025	BOSTON	SUFFOLK PSD	650142.	55.	11821.	B
25027	WORCHESTER	WORCESTER	646352.	1532.	422.	D
33001	LACONIA	BELKNAP	42884.	401.	107.	
33003	CONWAY	CARROLL	27931.	938.	30.	
33005	KEENE	CHESHIRE	62116.	717.	87.	
33007	GORHAM	COOS	35147.	1825.	19.	
33009	PLYMOUTH	GRAFTON	65806.	1717.	38.	
33011	NASHUA	HILLSBOROUGH	276608.	890.	311.	C
33013	CONCORD	MERRIMACK	98302.	931.	106.	
33015	PORTSMOUTH	ROCKINGHAM	190345.	691.	275.	D X
33017	ROCHESTER	STRAFFORD	85408.	377.	[illegible]	
33019	CLAREMONT	SULLIVAN	36063.	537.	67.	
44001	BRISTOL	BRISTOL	46942.	25.	[illegible]	
44003	EAST GREENWICH	KENT	154163.	172.	896.	
44005	NEWPORT	NEWPORT	81383.	115.	708.	C
44007	ESMOND	PROVIDENCE	571349.	422.	1354.	B
44009	WYOMING	WASHINGTON	93317.	324.	288.	D X
50001	VERGENNES	ADDISON	29406.	785.	37.	
50003	BENNINGTON	BENNINGTON	33345.	672.	50.	
50005	SAINT JOHNSBURG	CALEDONIA	25808.	614.	42.	
50007	BURLINGTON	CHITTENDEN	115534.	532.	217.	C
50009	ISLAND POND	ESSEX	6313.	664.	10.	
50011	SAINT ALBANS	FRANKLIN	34788.	659.	53.	
50013	GRAND ISLE	GRAND ISLE	4613.	77.	60.	
50015	MORRISVILLE	LAMOILLE	16767.	475.	35.	
50017	WEST TOPSHAM	ORANGE	22739.	690.	33.	
50019	NEWPORT	ORLEANS	23440.	715.	33.	
50021	RUTLAND	RUTLAND	58347.	929.	63.	
50023	MONTPELIER	WASHINGTON	52393.	708.	74.	
50025	BRATTLEBARE	WINDHAM	36933.	793.	47.	
50027	WILDER	WINDSOR	51030.	965.	53.	

!TABLE 1.1

EVACUATION COUNTY	RESIDENTS	AREA	DENSITY	AT RISK POP.	REC. CAPACITY
NEW LONDON	238409.	672.	354.78	214568.	4057976.
AROOSTOOK	91331.	6805.	13.42	82198.	1554523.
YORK	139666.	1000.	139.67	125699.	4120572.
HAMPDEN	443018.	621.	713.39	398716.	4093977.
SUFFOLK PSD	650142.	55.	11820.76	622642.	4223664.
HILLSBOROUGH	276608.	890.	310.80	248947.	4223664.
ROCKINGHAM	190345.	691.	275.46	171310.	4120572.
NEWPORT	81383.	115.	707.68	73245.	4223664.
PROVIDENCE	571349.	422.	1353.91	514214.	4223664.
WASHINGTON	93317.	324.	288.02	83985.	4223664.
CHITTENDEN	115534.	532.	217.17	103981.	4144862.

RECEPTION COUNTY	RESIDENTS	AREA	DENSITY	CRITERION	REC. CAPACITY
LITCHFIELD	156769.	938.	167.13	DENSITY	312231.
TOLLAND	114823.	416.	276.02	DENSITY	93177.
WINDHAM	92312.	516.	178.90	DENSITY	165683.
ANDROSCOGGIN	99657.	478.	208.49	DENSITY	139343.
CUMBERLAND	215789.	881.	244.94	DENSITY	224711.
FRANKLIN	27098.	1717.	15.78	MULTIPLE	54196.
HANCOCK	41781.	1542.	27.10	MULTIPLE	83562.
KENNEBEC	109889.	865.	127.04	MULTIPLE	219778.
KNOX	32941.	362.	91.00	MULTIPLE	65882.
LINCOLN	25691.	457.	56.22	MULTIPLE	51382.
OXFORD	48968.	2085.	23.49	MULTIPLE	97936.
PENOBSCOT	137015.	3408.	40.20	MULTIPLE	274030.
SAGADAHOC	28795.	257.	112.04	MULTIPLE	57590.
SOMERSET	45028.	3948.	11.41	MULTIPLE	90056.
WALDO	28414.	734.	38.71	MULTIPLE	56828.
WASHINGTON	34963.	2553.	13.69	MULTIPLE	69926.
BERKSHIRE	145110.	942.	154.04	MULTIPLE	290220.
DUKES	8942.	106.	84.36	MULTIPLE	17884.
FRANKLIN	64317.	722.	89.08	MULTIPLE	128634.
HAMPSHIRE	138813.	537.	258.50	DENSITY	129687.
NANTUCKET	5087.	46.	110.59	MULTIPLE	10174.
BELKNAP	42884.	401.	106.94	MULTIPLE	85768.
CARROLL	27931.	938.	29.78	MULTIPLE	55862.
CHESHIRE	62116.	717.	86.63	MULTIPLE	124232.
COOS	35147.	1825.	19.26	MULTIPLE	70294.
GRAFTON	65806.	1717.	38.33	MULTIPLE	131612.
MERRIMACK	98302.	931.	105.59	MULTIPLE	196604.
STRAFFORD	85408.	377.	226.55	DENSITY	103092.
SULLIVAN	36063.	537.	67.16	MULTIPLE	72126.
ADDISON	29406.	785.	37.46	MULTIPLE	58812.
BENNINGTON	33345.	672.	49.62	MULTIPLE	66690.
CALEDONIA	25808.	614.	42.03	MULTIPLE	51616.
FRANKLIN	34788.	659.	52.79	MULTIPLE	69576.
GRAND ISLE	4613.	77.	59.91	MULTIPLE	9226.
LAMOILLE	16767.	475.	35.30	MULTIPLE	33534.
ORANGE	22739.	690.	32.96	MULTIPLE	45478.
ORLEANS	23440.	715.	32.78	MULTIPLE	46880.
RUTLAND	58347.	929.	62.81	MULTIPLE	116694.
WASHINGTON	52393.	708.	74.00	MULTIPLE	104786.
WINDHAM	36933.	793.	46.57	MULTIPLE	73866.
WINDSOR	51030.	965.	52.88	MULTIPLE	102060.

1TABLE 1.2

EVACUATION/RECEPTION COUNTY PAIRS

PAIR	PEOPLE	ORIGIN	COUNTY	DESTINATION	COUNTY	HOURS	MILES	DENSITY
1	22687.	ESMOND	PROVIDENCE	BENNINGTON	BENNINGTON	2.91	130.	33.38
2	57590.	BOSTON	SUFFOLK PSD	BATH	SAGADAHOC	2.44	134.	336.13
3	13644.	BOSTON	SUFFOLK PSD	LEWISTON	ANDROSCOGGIN	2.36	130.	500.00
4	13678.	NEWPORT	NEWPORT	WINSTEAD	LITCHFIELD	2.34	115.	500.00
5	102060.	BOSTON	SUFFOLK PSD	WILDER	WINDSOR	2.28	125.	158.64
6	72126.	BOSTON	SUFFOLK PSD	CLAREMONT	SULLIVAN	2.16	113.	[illegible].47
7	73866.	ESMOND	PROVIDENCE	BRATTLEBARE	WINDHAM	2.12	98.	139.72
8	68539.	ESMOND	PROVIDENCE	KEENE	CHESHIRE	2.09	85.	259.90
9	82198.	HOULTON	AROOSTOOK	BANGOR	PENOBSCOT	2.03	112.	64.32
10	83985.	WYOMING	WASHINGTON	WINSTEAD	LITCHFIELD	2.01	99.	500.00
11	53401.	BOSTON	SUFFOLK PSD	PORTLAND	CUMBERLAND	1.91	105.	500.00
12	24126.	BOSTON	SUFFOLK PSD	LACONIA	BELKNAP	1.84	96.	320.83
13	20138.	ESMOND	PROVIDENCE	GREENFIELD	FRANKLIN	1.81	81.	267.25
14	129687.	ESMOND	PROVIDENCE	NORTHHAMPTON	HAMPSHIRE	1.58	72.	500.00
15	55693.	NASHUA	HILLSBOROUGH	KEENE	CHESHIRE	1.42	42.	259.90
16	103092.	BOSTON	SUFFOLK PSD	ROCHESTER	STRAFFORD	1.40	77.	500.00
17	131612.	NASHUA	HILLSBOROUGH	PLYMOUTH	GRAFTON	1.35	74.	114.98
18	214568.	NORWICH	NEW LONDON	WINSTEAD	LITCHFIELD	1.31	61.	500.00
19	61642.	NASHUA	HILLSBOROUGH	LACONIA	BELKNAP	1.23	62.	320.83
20	196604.	BOSTON	SUFFOLK PSD	CONCORD	MERRIMACK	1.21	66.	316.78
21	93177.	ESMOND	PROVIDENCE	BOLTON	TOLLAND	1.19	47.	500.00
22	125699.	SANFORD	YORK	LEWISTON	ANDROSCOGGIN	1.15	53.	500.00
23	290220.	SPRINGFIELD	HAMPDEN	PITTSFIELD	BERKSHIRE	1.10	56.	462.13
24	59567.	NEWPORT	NEWPORT	DANIELSON	WINDHAM	1.05	48.	500.00
25	171310.	PORTSMOUTH	ROCKINGHAM	PORTLAND	CUMBERLAND	.86	47.	500.00
26	108496.	SPRINGFIELD	HAMPDEN	GREENFIELD	FRANKLIN	.62	34.	267.25
27	45169.	BURLINGTON	CHITTENDEN	MONTPELIER	WASHINGTON	.62	34.	137.80
28	106121.	ESMOND	PROVIDENCE	DANIELSON	WINDHAM	.58	25.	500.00
29	58812.	BURLINGTON	CHITTENDEN	VERGENNES	ADDISON	.55	22.	112.38

TABLE 2.2

ROUTE CHARACTERISTICS AND LOADINGS

			FROM		TO			AVERAGE HOURS		
ROUTE	PAIR	EVACUEES	CITY	COUNTY	CITY	COUNTY	DISTANCE	TRAVEL	DELAY	TOTAL
1	1	22686.	ESMOND	PROVIDENCE	BENNINGTON	BENNINGTON	129.7	3.40	5.21	8.61
2	2	57590.	BOSTON	SUFFOLK PSD	BATH	SAGADAHOC	132.4	2.94	4.62	7.57
3	3	759.	NEWPORT	NEWPORT	WINSTEAD	LITCHFIELD	106.6	2.77	4.43	7.20
30	3	12919.	NEWPORT	NEWPORT	WINSTEAD	LITCHFIELD	133.9	3.05	4.12	7.17
4	4	39008.	BOSTON	SUFFOLK PSD	WILDER	WINDSOR	124.6	2.77	6.12	8.89
35	4	736.	BOSTON	SUFFOLK PSD	WILDER	WINDSOR	127.2	2.94	5.99	8.93
42	4	62316.	BOSTON	SUFFOLK PSD	WILDER	WINDSOR	133.0	3.32	5.57	8.89
5	5	69160.	BOSTON	SUFFOLK PSD	CLAREMONT	SULLIVAN	111.7	2.58	6.12	8.70
36	5	2966.	BOSTON	SUFFOLK PSD	CLAREMONT	SULLIVAN	114.3	2.75	5.99	8.74
6	6	73866.	ESMOND	PROVIDENCE	BRATTLEBARE	WINDHAM	98.1	2.50	5.21	7.71
9	7	68539.	ESMOND	PROVIDENCE	KEENE	CHESHIRE	84.4	2.32	4.70	7.02
7	8	82198.	HOULTON	AROOSTOOK	BANGOR	PENOBSCOT	111.5	2.48	4.00	6.48
3	9	4568.	WYOMING	WASHINGTON	WINSTEAD	LITCHFIELD	90.7	2.38	4.43	6.81
31	9	79417.	WYOMING	WASHINGTON	WINSTEAD	LITCHFIELD	118.0	2.66	4.12	6.78
10	10	67044.	BOSTON	SUFFOLK PSD	PORTLAND	CUMBERLAND	103.0	2.29	4.62	6.91
11	11	23130.	BOSTON	SUFFOLK PSD	LACONIA	BELKNAP	94.7	2.20	6.12	8.32
37	11	996.	BOSTON	SUFFOLK PSD	LACONIA	BELKNAP	97.3	2.37	5.99	8.36
12	12	20138.	ESMOND	PROVIDENCE	GREENFIELD	FRANKLIN	80.8	2.11	5.21	7.32
13	13	115722.	ESMOND	PROVIDENCE	NORTHHAMPTON	HAMPSHIRE	71.7	1.85	5.16	7.02
45	13	13965.	ESMOND	PROVIDENCE	NORTHHAMPTON	HAMPSHIRE	119.0	2.77	4.31	7.08
20	14	55693.	NASHUA	HILLSBOROUGH	KEENE	CHESHIRE	42.5	1.42	4.00	5.42
14	15	103092.	BOSTON	SUFFOLK PSD	ROCHESTER	STRAFFORD	75.6	1.68	4.00	5.68
15	16	48844.	NASHUA	HILLSBOROUGH	PLYMOUTH	GRAFTON	74.2	1.65	6.12	7.77
33	16	82768.	NASHUA	HILLSBOROUGH	PLYMOUTH	GRAFTON	74.2	1.76	5.99	7.75
17	17	93425.	NORWICH	NEW LONDON	WINSTEAD	LITCHFIELD	61.3	1.55	4.43	5.97
32	17	121143.	NORWICH	NEW LONDON	WINSTEAD	LITCHFIELD	88.3	1.96	4.00	5.96
16	18	13644.	PORTSMOUTH	ROCKINGHAM	LEWISTON	ANDROSCOGGIN	72.0	1.60	4.62	6.22
18	19	22678.	NASHUA	HILLSBOROUGH	LACONIA	BELKNAP	61.8	1.47	6.12	7.59
34	19	38765.	NASHUA	HILLSBOROUGH	LACONIA	BELKNAP	61.8	1.58	5.99	7.57
43	19	200.	NASHUA	HILLSBOROUGH	LACONIA	BELKNAP	79.5	2.41	5.57	7.98
19	20	188398.	BOSTON	SUFFOLK PSD	CONCORD	MERRIMACK	65.6	1.46	6.12	7.58
39	20	8206.	BOSTON	SUFFOLK PSD	CONCORD	MERRIMACK	68.2	1.63	5.99	7.62
21	21	93177.	ESMOND	PROVIDENCE	BOLTON	TOLLAND	47.5	1.36	4.16	5.52
22	22	119039.	SANFORD	YORK	LEWISTON	ANDROSCOGGIN	52.9	1.35	5.34	6.69
38	22	6660.	SANFORD	YORK	LEWISTON	ANDROSCOGGIN	78.4	2.33	4.35	6.69
23	23	129561.	SPRINGFIELD	HAMPDEN	PITTSFIELD	BERKSHIRE	56.0	1.32	5.76	7.08
40	23	126503.	SPRINGFIELD	HAMPDEN	PITTSFIELD	BERKSHIRE	54.4	1.43	5.67	7.10
46	23	34156.	SPRINGFIELD	HAMPDEN	PITTSFIELD	BERKSHIRE	97.6	2.65	4.46	7.11
24	24	59402.	NEWPORT	NEWPORT	DANIELSON	WINDHAM	48.2	1.23	5.51	6.75
47	24	165.	NEWPORT	NEWPORT	DANIELSON	WINDHAM	91.2	2.51	4.39	6.90
25	25	157667.	PORTSMOUTH	ROCKINGHAM	PORTLAND	CUMBERLAND	46.3	1.04	4.62	5.66
41	26	108496.	SPRINGFIELD	HAMPDEN	GREENFIELD	FRANKLIN	34.1	.76	4.46	5.22
27	27	45169.	BURLINGTON	CHITTENDEN	MONTPELIER	WASHINGTON	34.0	.75	4.00	4.75
28	28	64284.	ESMOND	PROVIDENCE	DANIELSON	WINDHAM	24.7	.67	5.51	6.19
44	28	41837.	ESMOND	PROVIDENCE	DANIELSON	WINDHAM	56.0	1.80	4.39	6.19
29	29	58812.	BURLINGTON	CHITTENDEN	VERGENNES	ADDISON	22.1	.53	4.00	4.53

1TABLE 3.1

EVACUATION DEPARTURE SUMMARY

EVACUATION COUNTY	EVACUEES	2	4	6	8	12	16	20	24	32	40	48	60	72	84
		PERCENTAGE DEPARTED AT ELAPSED HOUR													
PROVIDENCE	514214.	20	41	61	82	99	99	99	99	99	99	99	99	99	99
SUFFOLK PSD	622641.	19	38	57	76	99	99	99	99	99	99	99	99	99	99
NEWPORT	73245.	19	38	57	77	99	99	99	99	99	99	99	99	99	99
AROOSTOOK	82198.	24	49	74	99	99	99	99	99	99	99	99	99	99	99
WASHINGTON	83985.	24	48	72	96	99	99	99	99	99	99	99	99	99	99
HILLSBOROUGH	248947.	18	36	55	73	99	99	99	99	99	99	99	99	99	99
ROCKINGHAM	171310.	21	43	64	86	99	99	99	99	99	99	99	99	99	99
NEW LONDON	214568.	23	47	71	95	99	99	99	99	99	99	99	99	99	99
YORK	125699.	18	37	56	75	99	99	99	99	99	99	99	99	99	99
HAMPDEN	398716.	19	38	57	77	99	99	99	99	99	99	99	99	99	99
CHITTENDEN	103981.	24	49	74	99	99	99	99	99	99	99	99	99	99	99

1TABLE 3.2

RECEPTION ARRIVAL SUMMARY

RECEPTION COUNTY	EVACUEES	2	4	6	8	12	16	20	24	32	40	48	60	72	84
		PERCENTAGE ARRIVED AT ELAPSED HOUR													
BENNINGTON	22686.	0	5	24	44	82	99	99	99	99	99	99	99	99	99
SAGADAHOC	57590.	0	11	33	54	97	99	99	99	99	99	99	99	99	99
LITCHFIELD	312231.	1	22	47	71	99	99	99	99	99	99	99	99	99	99
WINDSOR	102050.	0	7	24	42	76	99	99	99	99	99	99	99	99	99
SULLIVAN	72126.	0	11	27	44	76	99	99	99	99	99	99	99	99	99
WINDHAM	73866.	0	14	33	52	91	99	99	99	99	99	99	99	99	99
PENOBSCOT	82198.	0	19	44	69	99	99	99	99	99	99	99	99	99	99
CHESHIRE	124232.	3	24	47	70	99	99	99	99	99	99	99	99	99	99
CUMBERLAND	224711.	7	27	49	71	99	99	99	99	99	99	99	99	99	99
BELKNAP	85768.	2	18	35	51	84	99	99	99	99	99	99	99	99	99
FRANKLIN	128634.	11	33	55	77	99	99	99	99	99	99	99	99	99	99
HAMPSHIRE	129687.	1	20	39	59	98	99	99	99	99	99	99	99	99	99
STRAFFORD	103092.	4	29	54	79	99	99	99	99	99	99	99	99	99	99
GRAFTON	131612.	2	18	35	52	85	99	99	99	99	99	99	99	99	99
ANDROSCOGGIN	139343.	5	24	43	63	99	99	99	99	99	99	99	99	99	99
MERRIMACK	196604.	4	20	37	53	86	99	99	99	99	99	99	99	99	99
TOLLAND	93177.	7	31	55	79	99	99	99	99	99	99	99	99	99	99
BERKSHIRE	290220.	4	22	40	58	93	99	99	99	99	99	99	99	99	99
WINDHAM	165688.	7	27	46	65	99	99	99	99	99	99	99	99	99	99
WASHINGTON	45169.	15	40	65	90	99	99	99	99	99	99	99	99	99	99
ADDISON	58812.	17	42	67	92	99	99	99	99	99	99	99	99	99	99

TABLE 3.3

NETWORK LINK CHARACTERISTICS AND LOADINGS

FROM	TO	ROUTE NAME	DIST.	SPEED	CAP.	PERCENTAGE OF CAPACITY IN USE AT ELAPSED HOURS 2	4	6	8	12	16	20	24	32	40	48	[illegible]	[illegible]
AVON	WINSTEAD	U.S. ROUTE 44	20.2	35.0	2800.	96	100	100	100	0	0	0	0	0	0			
ASHFORD	BOLTON	U.S. ROUTE 544	13.3	35.0	2800.	100	100	100	100	0	0	0	0	0				
SOUTH FOSTER	DANIELSON	U.S. ROUTE 6	10.8	35.0	2800.	100	100	100	100	41	0	0	0	0	0	0		
PUTNAM	ASHFORD	U.S. ROUTE 44	12.5	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0		
CHEPACHET	PUTNAM	U.S. ROUTE 44	13.0	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0		
HARTFORD	AVON	U.S. ROUTE 44	8.5	35.0	2800.	99	100	100	100	0	0	0	0	0	0	0	0	
MERIDAN	MILLDALE	STATE ROAD 66	5.4	35.0	2800.	86	100	100	100	0	0	0	0	0	0	0	0	
PORTLAND	LEWISTON	STATE ROAD 900	25.2	45.0	4000.	81	84	84	84	3	0	0	0	0	0	0	0	
BIDDLEFORD	PORTLAND	INTERSTATE 95	12.8	45.0	8000.	58	100	100	100	0	0	0	0	0	0	0		
SANFORD	PORTLAND	U.S. ROUTE 202	27.7	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0		
PORTSMOUTH	BIDDLEFORD	INTERSTATE 95	34.0	45.0	8000.	100	100	100	100	0	0	0	0	0	0	0		
LEE	PITTSFIELD	U.S. ROUTE 7	12.4	35.0	2800.	101	101	101	101	101	0	0	0	0	0	0	0	
NORTHHAMPTON	PITTSFIELD	STATE ROAD 9	35.4	35.0	2800.	100	100	100	100	76	0	0	0	0	0	0	0	
NORTHHAMPTON	GREENFIELD	INTERSTATE 91	15.0	45.0	4000.	100	100	100	100	0	0	0	0	0	0	0		
ORANGE	GREENFIELD	STATE ROAD 2	15.0	35.0	2800.	74	100	100	100	100	0	0	0	0	0	0	0	0
CHICOPEE	NORTHHAMPTON	U.S. ROUTE 5	14.0	35.0	1400.	68	97	97	97	0	0	0	0	0	0	0	0	
BELCHERTOWN	NORTHHAMPTON	STATE ROAD 9	11.4	35.0	2800.	100	100	100	100	55	0	0	0	0	0	0		
SLATERSVILLE	WORCHESTER	STATE ROAD 146	18.3	45.0	8000.	93	93	93	93	0	0	0	0	0	0	0		
WESTFIELD	LEE	INTERSTATE 90	31.3	45.0	4000.	70	70	70	70	48	0	0	0	0	0	0	0	
BOSTON	LAWRENCE	INTERSTATE 93	25.3	45.0	8000.	82	82	82	82	82	0	0	0	0	0	0	0	0
WORCHESTER	BELCHERTOWN	STATE ROAD 9	29.3	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0	0	0
WORCHESTER	ORANGE	STATE ROAD 122	34.7	35.0	2800.	100	100	100	100	10	0	0	0	0	0	0	0	0
CHICOPEE	WESTFIELD	INTERSTATE 90	7.3	45.0	4000.	70	70	70	70	0	0	0	0	0	0	0	0	0
NORTHFIELD	PLYMOUTH	INTERSTATE 93	28.0	45.0	4000.	68	68	68	68	68	0	0	0	0	0	0	0	0
MANCHESTER	CONCORD	INTERSTATE 93	17.5	45.0	8000.	100	100	100	100	100	0	0	0	0	0	0		
MANCHESTER	CONCORD	U.S. ROUTE 3	17.5	35.0	2800.	100	100	100	100	100	0	0	0	0	0	0	0	0
LAWRENCE	MANCHESTER	INTERSTATE 93	22.8	45.0	8000.	82	82	82	82	82	0	0	0	0	0	0	0	0
NASHUA	MANCHESTER	U.S. ROUTE 3	15.1	35.0	1400.	100	100	100	100	93	0	0	0	0	0	0	0	0
ESMOND	ASTON	INTERSTATE 295	4.5	45.0	8000.	93	93	93	93	0	0	0	0	0	0	0	0	0
JOHNSTON	SOUTH FOSTER	U.S. ROUTE 6	8.5	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0	0	0
WYOMING	SOUTH FOSTER	STATE ROAD 102	24.0	30.0	1200.	100	100	100	100	0	0	0	0	0	0	0	0	0
ESMOND	CHEPACHET	U.S. ROUTE 44	8.5	35.0	2800.	100	100	100	100	0	0	0	0	0	0	0	0	0
ASTON	SLATERSVILLE	STATE ROAD 146	7.8	45.0	8000.	93	93	93	93	0	0	0	0	0	0	0	0	0

3.3 Route Listing

Each route is displayed in detail in Table 2.3. The routes appear in the same order in which they are summarized in Table 2.2. Since Table 2.3 is long and quite detailed, only the part of it corresponding to the first nine routes of Table 2.2 has been reproduced below.

The sequence of nodes proceeding from the origin to the destination is shown for each route. For each node (or link into the node) the following information is given:

NODE - the 5-digit FIPS code of the state/county with the node's single-digit sequence number added as the sixth digit.

CODE - a code number embedding the highway segment's characteristics and number.

TRAVEL - elapsed travel time to the node at evacuation speeds.

DELAY - elapsed delay time, i.e., the longest average delay time imposed by a congested link already listed.

TOTAL - TRAVEL plus DELAY time.

DIST - accumulated distance in miles.

SPEED - link evacuation speed in miles/hour.

CAP - link evacuation capacity in vehicles/hour for all available lanes.

VCLS - number of vehicles using the link according to the route loading.

PLACE NAME - name of county center.

COUNTY - county name.

ROUTE NAME - highway type and number.

1TABLE 2.3

ROUTE 1

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
440070	12295	.00	4.00	4.00	.0	.0	0.	0.	ESMOND	PROVIDENCE	INTERSTATE 295
440071	12295	.10	4.70	4.80	4.5	45.0	8000.	75224.	ASTON	PROVIDENCE	INTERSTATE 295
440077	33146	.27	4.70	4.97	12.3	45.0	8000.	75224.	SLATERSVILLE	PROVIDENCE	STATE ROAD 146
250270	33146	.69	4.70	5.39	31.1	45.0	8000.	75224.	WORCHESTER	WORCESTER	STATE ROAD 146
250112	35122	1.68	5.21	6.89	65.8	35.0	2800.	29173.	ORANGE	FRANKLIN	STATE ROAD 122
250110	35002	2.11	5.21	7.32	80.8	35.0	2800.	29173.	GREENFIELD	FRANKLIN	STATE ROAD 2
250111	12091	2.25	5.21	7.46	87.1	45.0	4000.	24138.	BERNARDSTON	FRANKLIN	INTERSTATE 91
500250	12091	2.50	5.21	7.71	98.1	45.0	4000.	24138.	BRATTLEBARE	WINDHAM	INTERSTATE 91
500030	35009	3.40	5.21	8.61	129.7	35.0	1400.	5672.	BENNINGTON	BENNINGTON	STATE ROAD 9

ROUTE 2

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	12095	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	INTERSTATE 95
250090	12095	.34	4.00	4.34	15.5	45.0	8000.	56931.	DANVERS	ESSEX	INTERSTATE 95
250093	12095	.79	4.00	4.79	35.5	45.0	8000.	56931.	AMESBURY	ESSEX	INTERSTATE 95
330151	12095	1.06	4.00	5.06	47.6	45.0	8000.	56931.	HAMPTON	ROCKINGHAM	INTERSTATE 95
330150	12095	1.25	4.00	5.25	56.1	45.0	8000.	56931.	PORTSMOUTH	ROCKINGHAM	INTERSTATE 95
230311	12095	2.00	4.62	6.63	90.1	45.0	8000.	73986.	BIDDLEFORD	YORK	INTERSTATE 95
230050	12095	2.29	4.62	6.91	103.0	45.0	8000.	73986.	PORTLAND	CUMBERLAND	INTERSTATE 95
230051	12095	2.81	4.62	7.43	126.4	45.0	4000.	14397.	BRUNSWICK	CUMBERLAND	INTERSTATE 95
230230	23001	2.94	4.62	7.57	132.4	45.0	4000.	14397.	BATH	SAGADAHOC	U.S. ROUTE 1

ROUTE 3

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
440050	35138	.00	4.00	4.00	.0	.0	0.	0.	NEWPORT	NEWPORT	STATE ROAD 138
440092	35138	.17	4.00	4.17	6.1	35.0	2800.	18270.	SAUNDERSTOWN	WASHINGTON	STATE ROAD 138
440091	23001	.63	4.00	4.63	26.7	45.0	4000.	3419.	WESTERLY	WASHINGTON	U.S. ROUTE 1
90111	12095	.68	4.00	4.68	28.9	45.0	4000.	24416.	PAWCATUCK	NEW LONDON	INTERSTATE 95
90110	36002	1.22	4.00	5.22	45.2	30.0	1200.	1337.	NORWICH	NEW LONDON	STATE ROAD 2
90113	33002	1.52	4.00	5.52	58.6	45.0	8000.	54979.	COLCHESTER	NEW LONDON	STATE ROAD 2
90037	33002	1.63	4.00	5.63	63.6	45.0	8000.	54979.	MARLBORO	HARTFORD	STATE ROAD 2
90030	33002	1.95	4.00	5.95	77.8	45.0	8000.	54979.	HARTFORD	HARTFORD	STATE ROAD 2
90035	25044	2.19	4.43	6.62	86.3	35.0	2800.	24787.	AVON	HARTFORD	U.S. ROUTE 44
90050	25044	2.77	4.43	7.20	106.6	35.0	2800.	24787.	WINSTEAD	LITCHFIELD	U.S. ROUTE 44

ROUTE 30

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
440050	35138	.00	4.00	4.00	.0	.0	0.	0.	NEWPORT	NEWPORT	STATE ROAD 138
440092	35138	.17	4.00	4.17	6.1	35.0	2800.	18270.	SAUNDERSTOWN	WASHINGTON	STATE ROAD 138
440091	23001	.63	4.00	4.63	26.7	45.0	4000.	3419.	WESTERLY	WASHINGTON	U.S. ROUTE 1
90111	12095	.68	4.00	4.68	28.9	45.0	4000.	24416.	PAWCATUCK	NEW LONDON	INTERSTATE 95
90112	12095	.95	4.00	4.95	41.0	45.0	4000.	23079.	NEW LONDON	NEW LONDON	INTERSTATE 95
90070	12095	1.32	4.00	5.32	57.7	45.0	4000.	23079.	OLD SAYBROOK	MIDDLESEX	INTERSTATE 95
90071	33009	1.70	4.00	5.70	74.8	45.0	4000.	23079.	MIDDLETOWN	MIDDLESEX	STATE ROAD 9
90034	33009	1.91	4.00	5.91	84.0	45.0	4000.	23079.	EAST BERLIN	HARTFORD	STATE ROAD 9
90093	11091	2.10	4.00	6.10	92.6	45.0	6000.	23079.	MERIDAN	NEW HAVEN	INTERSTATE 91
90036	35066	2.25	4.12	6.37	98.0	35.0	2800.	23079.	MILLDALE	HARTFORD	STATE ROAD 66
90091	12084	2.52	4.12	6.64	110.0	45.0	8000.	53271.	WATERBURY	NEW HAVEN	INTERSTATE 84
90052	33008	2.59	4.12	6.71	113.2	45.0	8000.	53271.	THOMASTOWN	LITCHFIELD	STATE ROAD 8
90054	33008	2.86	4.12	6.98	125.3	45.0	8000.	53271.	TORRINGTON	LITCHFIELD	STATE ROAD 8
90050	33008	3.05	4.12	7.17	133.9	45.0	8000.	53271.	WINSTEAD	LITCHFIELD	STATE ROAD 8

ROUTE 4

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	12093	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	INTERSTATE 93
250091	12093	.56	5.00	5.56	25.3	45.0	8000.	79951.	LAWRENCE	ESSEX	INTERSTATE 93
330111	12093	1.07	5.00	6.07	48.1	45.0	8000.	79951.	MANCHESTER	HILLSBOROUGH	INTERSTATE 93
330130	12093	1.46	6.12	7.58	65.6	45.0	8000.	97903.	CONCORD	MERRIMACK	INTERSTATE 93
330133	12089	1.64	6.12	7.76	73.6	45.0	4000.	28007.	HOPKINTOWN	MERRIMACK	INTERSTATE 89
330135	12089	2.12	6.12	8.24	95.6	45.0	8000.	43546.	NEW LONDON	MERRIMACK	INTERSTATE 89
330091	12089	2.59	6.12	8.71	116.6	45.0	4000.	25515.	LEBANON	GRAFTON	INTERSTATE 89
500270	12089	2.77	6.12	8.89	124.6	45.0	4000.	25515.	WILDER	WINDSOR	INTERSTATE 89

ROUTE 35

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	23003	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	U.S. ROUTE 3
250171	23003	.62	4.00	4.62	27.8	45.0	4000.	18778.	LOWELL	MIDDLESEX	U.S. ROUTE 3
330110	22003	.79	4.00	4.79	35.6	45.0	4000.	18778.	NASHUA	HILLSBOROUGH	U.S. ROUTE 3
330111	32900	1.13	4.00	5.13	50.7	45.0	8000.	51502.	MANCHESTER	HILLSBOROUGH	STATE ROAD 900
330130	25003	1.63	5.99	7.62	68.2	35.0	2800.	33550.	CONCORD	MERRIMACK	U.S. ROUTE 3
330133	12089	1.81	5.99	7.80	76.3	45.0	4000.	28007.	HOPKINTOWN	MERRIMACK	INTERSTATE 89
330135	12089	2.29	5.99	8.28	98.2	45.0	8000.	43546.	NEW LONDON	MERRIMACK	INTERSTATE 89
330091	12089	2.76	5.99	8.75	119.2	45.0	4000.	25515.	LEBANON	GRAFTON	INTERSTATE 89
500270	12089	2.94	5.99	8.93	127.2	45.0	4000.	25515.	WILDER	WINDSOR	INTERSTATE 89

ROUTE 42

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	23003	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	U.S. ROUTE 3
250171	23003	.62	4.00	4.62	27.8	45.0	4000.	18778.	LOWELL	MIDDLESEX	U.S. ROUTE 3
330110	22003	.79	4.00	4.79	35.6	45.0	4000.	18778.	NASHUA	HILLSBOROUGH	U.S. ROUTE 3
330111	25003	1.22	5.57	6.79	50.7	35.0	1400.	15589.	MANCHESTER	HILLSBOROUGH	U.S. ROUTE 3
330132	36114	2.03	5.57	7.60	74.9	30.0	2400.	15589.	HENNIKER	MERRIMACK	STATE ROAD 114
330133	23202	2.19	5.57	7.75	82.0	45.0	4000.	15589.	HOPKINTOWN	MERRIMACK	U.S. ROUTE 202
330135	12089	2.67	5.57	8.24	103.9	45.0	8000.	43546.	NEW LONDON	MERRIMACK	INTERSTATE 89
330091	12089	3.14	5.57	8.71	125.0	45.0	4000.	25515.	LEBANON	GRAFTON	INTERSTATE 89
500270	12089	3.32	5.57	8.89	133.0	45.0	4000.	25515.	WILDER	WINDSOR	INTERSTATE 89

ROUTE 5

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	12093	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	INTERSTATE 93
250091	12093	.56	5.00	5.56	25.3	45.0	8000.	79951.	LAWRENCE	ESSEX	INTERSTATE 93
330111	12093	1.07	5.00	6.07	48.1	45.0	8000.	79951.	MANCHESTER	HILLSBOROUGH	INTERSTATE 93
330130	12093	1.46	6.12	7.58	65.6	45.0	8000.	97903.	CONCORD	MERRIMACK	INTERSTATE 93
330133	12089	1.64	6.12	7.76	73.6	45.0	4000.	28007.	HOPKINTOWN	MERRIMACK	INTERSTATE 89
330135	12089	2.12	6.12	8.24	95.6	45.0	8000.	43546.	NEW LONDON	MERRIMACK	INTERSTATE 89
330191	35011	2.35	6.12	8.47	103.6	35.0	2800.	18031.	NEWPORT	SULLIVAN	STATE ROAD 11
330190	35011	2.58	6.12	8.70	111.7	35.0	2800.	18031.	CLAREMONT	SULLIVAN	STATE ROAD 11

ROUTE 36

NODE	CODE	TRAVEL	DELAY	TOTAL	DIST.	SPEED	CAP.	VCLS	PLACE NAME	COUNTY	ROUTE NAME
250250	23003	.00	4.00	4.00	.0	.0	0.	0.	BOSTON	SUFFOLK PSD	U.S. ROUTE 3
250171	23003	.62	4.00	4.62	27.8	45.0	4000.	18778.	LOWELL	MIDDLESEX	U.S. ROUTE 3
330110	22003	.79	4.00	4.79	35.6	45.0	4000.	18778.	NASHUA	HILLSBOROUGH	U.S. ROUTE 3
330111	32900	1.13	4.00	5.13	50.7	45.0	8000.	51502.	MANCHESTER	HILLSBOROUGH	STATE ROAD 900
330130	25003	1.63	5.99	7.62	68.2	35.0	2800.	33550.	CONCORD	MERRIMACK	U.S. ROUTE 3
330133	12089	1.81	5.99	7.80	76.3	45.0	4000.	28007.	HOPKINTOWN	MERRIMACK	INTERSTATE 89
330135	12089	2.29	5.99	8.28	98.2	45.0	8000.	43546.	NEW LONDON	MERRIMACK	INTERSTATE 89
330191	35011	2.52	5.99	8.51	106.2	35.0	2800.	18031.	NEWPORT	SULLIVAN	STATE ROAD 11
330190	35011	2.75	5.99	8.74	114.3	35.0	2800.	18031.	CLAREMONT	SULLIVAN	STATE ROAD 11

4.1 Program/Storage Size Limits

A number of constraints are imposed by program storage limits on the size of problems which can be handled by the model. These constraints are shown in the following table.

Constraint Item	Limit
Input/Output Channels 11-20	10
States per Regional Network	10
Regional Network Nodes	500
Regional Network Links	2000
Evacuation Counties	40
Reception Counties	500
Evacuation/Reception County Pairs	200
Routes on the Route List	500
Links per Route	19

These constraints limits have been set to conserve computer memory without excluding most applications. If necessary, the limits can be expanded by increasing array dimensions and making other minor changes in the programs.

4.2 Subprogram Descriptions

MAIN - A dummy main program which only calls MASTER.

MASTER - Operates the master control sequence.

PASS - Operates the route selection and loading algorithm.

ORDER - Reorders the link list for a regional network.

PRICE - Performs the first stage of the Ford-Fulkerson fastest route computation for a given destination.

ROUTE - Finds the fastest route from a given origin to a given destination.

COUNTY - Prints a table of county population centroids within a region.

LOCK - Locates a renumbered node from its FIPS code and sequence number.

STACK - Gets the nodes of a regional network from the Node File.

ROADS - Gets the links of a regional network from the Links File.

SAVER - Saves/retrieves preprocessed regional networks.

SHOW - Prints summary table and route listing on completion of the route selection and loading algorithn.

SORTR - Twig sort routine called by ORDER.

BUILD - Operates the assembly of a regional transportation network from the data base.

SETUP - Operates the direct input or computation of a crisis relocation plan.

LOADL - Performs an evacuation simulation for a single network link

EVAC - Operates the simulation of an evacuation given a set of route loadings.

LOADER - Computes traffic on all links given the number of evacuees using each route.

BLOCK - Blocks congested links at Step 4 of the Route Selection and Loading algorithm.

IFSAME - Checks a new route to see if it duplicates a route on the route list in Step 2.

TIMER - Computes average travel, delay and total time for a route.

HEADER - Prints a table heading.

TRNPLX - Main calling sequence for solving the linear program transportation problem.

RESET
XCK
SWAP
RESD
ROW
GET
DELTA
MIN
NEW
PIVOT

- Subroutines called directly/indirectly from TRNPLX.

4.3 Procedure Files. Elements

BPT*EXECUTE.COMPILE

Compiles source code to relocatable elements.

BPT*EXECUTE.ASSEMBLE

Assembles relocatable code elements.

BPT*EXECUTE.RUN

Executes program.

BPT*EXECUTE·COMPILE

```
@ASG,T OBJECT.
@PDP,FU BPT*SOURCE.COMMON,BPT*SOURCE.
@EOF
@FTN,NO BPT*SOURCE.MAIN,OBJECT.MAIN
@EOF
@FTN,NO BPT*SOURCE.MASTER,OBJECT.MASTER
@EOF
@FTN,NO BPT*SOURCE.PASS,OBJECT.PASS
@EOF
@FTN,NO BPT*SOURCE.ORDER,OBJECT.ORDER
@EOF
@FTN,NO BPT*SOURCE.PRICE,OBJECT.PRICE
@EOF
@FTN,NO BPT*SOURCE.ROUTE,OBJECT.ROUTE
@EOF
@FTN,NO BPT*SOURCE.STACK,OBJECT.STACK
@EOF
@FTN,NO BPT*SOURCE.COUNTY,OBJECT.COUNTY
@EOF
@FTN,NO BPT*SOURCE.LOCK,OBJECT.LOCK
@EOF
@FTN,NO BPT*SOURCE.ROADS,OBJECT.ROADS
@EOF
@FTN,NO BPT*SOURCE.SAVER,OBJECT.SAVER
@EOF
@FTN,NO BPT*SOURCE.SHOW,OBJECT.SHOW
@EOF
@FTN,NO BPT*SOURCE.SORTR,OBJECT.SORTR
@EOF
@FTN,NO BPT*SOURCE.BUILD,OBJECT.BUILD
@EOF
@FTN,NO BPT*SOURCE.SETUP,OBJECT.SETUP
@EOF
@FTN,NO BPT*SOURCE.LOADL,OBJECT.LOADL
@EOF
@FTN,NO BPT*SOURCE.EVAC,OBJECT.EVAC
@EOF
@FTN,NO BPT*SOURCE.LOADER,OBJECT.LOADER
@EOF
@FTN,NO BPT*SOURCE.BLOCK,OBJECT.BLOCK
@EOF
@FTN,NO BPT*SOURCE.IFSAME,OBJECT.IFSAME
@EOF
@FTN,NO BPT*SOURCE.TIMER,OBJECT.TIMER
@EOF
@FTN,NO BPT*SOURCE.HEADER,OBJECT.HEADER
@EOF
@FTN,NO BPT*SOURCE.TRNPLX,OBJECT.TRNPLX
@EOF
@FTN,NO BPT*SOURCE.RESET,OBJECT.RESET
@EOF
@FTN,NO BPT*SOURCE.XCK,OBJECT.XCK
@EOF
@FTN,NO BPT*SOURCE.SWAP,OBJECT.SWAP
@EOF
@FTN,NO BPT*SOURCE.RESD,OBJECT.RESD
@EOF
@FTN,NO BPT*SOURCE.ROW,OBJECT.ROW
@EOF
@FTN,NO BPT*SOURCE.GET,OBJECT.GET
@EOF
@FTN,NO BPT*SOURCE.DELTA,OBJECT.DELTA
@EOF
@FTN,NO BPT*SOURCE.MIN,OBJECT.MIN
@EOF
@FTN,NO BPT*SOURCE.NEW,OBJECT.NEW
@EOF
@FTN,NO BPT*SOURCE.PIVOT,OBJECT.PIVOT
@EOF
```

BPT*EXECUTE·ASSEMBLE

```
@MAP.EN ,OBJECT.SMAIN
IN OBJECT.MAIN
IN OBJECT.MASTER
IN OBJECT.PASS
IN OBJECT.ORDER
IN OBJECT.PRICE
IN OBJECT.ROUTE
IN OBJECT.STACK
IN OBJECT.COUNTY
IN OBJECT.LOCK
IN OBJECT.ROADS
IN OBJECT.SAVER
IN OBJECT.SHOW
IN OBJECT.SORTR
IN OBJECT.BUILD
IN OBJECT.SETUP
IN OBJECT.LOADL
IN OBJECT.EVAC
IN OBJECT.LOADER
IN OBJECT.BLOCK
IN OBJECT.TRNPLX
IN OBJECT.RESET
IN OBJECT.XCK
IN OBJECT.SWAP
IN OBJECT.RESD
IN OBJECT.ROW
IN OBJECT.GET
IN OBJECT.DELTA
IN OBJECT.MIN
IN OBJECT.NEW
IN OBJECT.PIVOT
IN OBJECT.TIMER
IN OBJECT.IFSAME
IN OBJECT.HEADER
@EOF
```

BPT*EXECUTE·RUN

```
@ASG,A BPT*USND.
@ASG,A BPT*USLD.
@ASG,A BPT*MAP.
@ASG,T FILE11.
@ASG,T FILE12.
@ASG,T FILE13.
@ASG,T FILE14.
@ASG,T FILE15.
@ASG,T FILE16.
@ASG,T FILE17.
@ASG,T FILE18.
@ASG,T FILE19.
@ASG,T FILE20.
@ASG,T ROUTES.
@USE 8,BPT*USND.
@USE 9,BPT*USLD.
@USE 10,BPT*MAP.
@USE 11,FILE11.
@USE 12,FILE12.
@USE 13,FILE13.
@USE 14,FILE14.
@USE 15,FILE15.
@USE 16,FILE16.
@USE 17,FILE17.
@USE 18,FILE18.
@USE 19,FILE19.
@USE 20,FILE20.
@USE 7,ROUTES.
@XQT OBJECT.SMAIN
```

4.4 Source Code Listings

COMMON Block Insert
Main Program

Subprograms:

- MASTER
- PASS
- ORDER
- PRICE
- ROUTE
- COUNTY
- STACK
- LOCKS
- ROADS
- SAVER
- SHOW
- SORTR
- BUILD
- SETUP
- LOADL
- EVAC
- LOADER
- BLOCK
- IFSAME
- TIMER
- HEADER

Transportation Subprograms:

- TRNPLX
- RESET
- XCK
- SWAP
- RESD
- ROW
- GET
- DELTA
- MIN
- NEW
- PIVOT

```
INSERT PROC
      LOGICAL OMIT
      DIMENSION IY(1),IA(1),ISS(1)
      COMMON /B1/IJR(21,500),JTO(2000),CR(500),DR(500)
      COMMON /B2/LFR(2000),IFR(2000),MFR(2000),CFR(2000),BFR(2000),DFR(2
     1000)
      COMMON /B3/NODES(3,500),IJPR(2,200),DENPR(200),JEV(100),OMIT(2000
     1,2),SNAMES(4,60),MAP(4,60)
      COMMON /B4/NOLOC(2,60),ANAMES(7,500),XLLOC(2,500),LLOC(500)
      COMMON /B5/Y(500,40),A(8000),S(2000)
      COMMON /B6/DSTLNK(2000),SPDLNK(2000),CAPLNK(2000)
      EQUIVALENCE (IY,Y),(IA,A),(ISS,S)
 END


C
       INCLUDE SOURCE.INSERT
C
C
      CALL MASTER
      STOP
      END




      SUBROUTINE MASTER
C MASTER CONTROL SEQUENCE
       INCLUDE SOURCE.INSERT
      DIMENSION NREG(60),NREADY(3)
      DATA KIN1,KIN2,KOUT1,KOUT2,KOUT3/5,5,6,6,7/
      DATA YES/'OK'/
      DATA NREADY/0,0,0/
      REWIND 10
    5 READ(10,501,END=10) J,(MAP(I,J),I=1,4),(SNAMES(I,J),I=1,4)
  501 FORMAT(5I6,2X,4A4)
      GO TO 5
   10 WRITE(KOUT1,666)
  666 FORMAT(/' LIST OF CONTROL OPTIONS'/' NO.  CONTROL OPTION'
     1/'  0   REPEAT LIST OF CONTROL OPTIONS'
     2/'  1   INPUT/COMPUTE CRISIS RELOCATION PLAN'
     2/'  2   RUN ROUTE FINDING/LOADING ALGORITHM'/
     2'  3   SIMULATE THE EVACUATION'/
     3'  4   ASSEMBLE NETWORK FROM DATA FILES'/
     4'  5   READ STORED NETWORK'/'  6   SAVE GENERATED NETWORK'
     5/'  7   REASSIGN INPUT CHANNEL FOR PARAMETER VALUES'
     6/'  8   REASSIGN OUTPUT CHANNEL FOR SUMMARY TABLES'
     7/'  9   REASSIGN OUTPUT CHANNEL FOR ROUTE LISTING'
     8/' 99   TERMINATE PROGRAM')
   20 WRITE(KOUT1,601)
  601 FORMAT(/' INPUT CONTROL OPTION NUMBER')
      READ(KIN1,*,ERR=20) I
      IF(I.NE.99) GO TO 25
      WRITE(KOUT1,608)
  608 FORMAT(1X,'TYPE "OK" TO TERMINATE')
      READ(KIN1,605) AYN
      IF(AYN.NE.YES) GO TO 20
      WRITE(KOUT1,609)
  609 FORMAT(1X,'PROGRAM ENDS')
      IF(KOUT2.NE.6) WRITE(KOUT2,620)
      IF(KOUT3.NE.6) WRITE(KOUT3,620)
  620 FORMAT(///1X)
      IF(KOUT2.NE.6) ENDFILE KOUT2
      IF(KOUT3.NE.6) ENDFILE KOUT3
      RETURN
   25 IF(I.LT.0.OR.I.GT.9) GO TO 20
      WRITE(KOUT1,603) I
  603 FORMAT(1X,'CONTROL OPTION ',I2,' TYPE "OK" TO EXECUTE')
      READ(KIN1,605,ERR=20) AYN
  605 FORMAT(A2)
      IF(AYN.NE.YES) GO TO 20
      IF(I.GE.4.AND.I.NE.6) GO TO 40
      IF(I.EQ.0) GO TO 40
```

```
      IF(I.LE.3.AND.NREADY(I).EQ.1) GO TO 40
      IF(I.EQ.6.AND.NREADY(1).EQ.1) GO TO 40
      IF(I.EQ.1) WRITE(KOUT1,611)
      IF(I.EQ.2) WRITE(KOUT1,612)
      IF(I.EQ.3) WRITE(KOUT1,613)
      IF(I.EQ.6) WRITE(KOUT1,611)
      GO TO 20
  611 FORMAT(' ERROR: NO NETWORK')
  612 FORMAT(' ERROR: NO EVACUATION PLAN')
  613 FORMAT(' ERROR: NO ROUTES')
   40 I1=I+1
      GO TO (10,30,100,250,200,300,300,310,320,320),I1
   30 CALL SETUP(KOUT1,KOUT2,KIN2,NN,NL,NREG,NPR,INFS)
      NREADY(2)=1
      IF(INFS.EQ.1) NREADY(2)=0
      NREADY(3)=0
      GO TO 20
  100 CALL PASS(KIN2,KOUT1,KOUT2,KOUT3,NN,NL,NPR,NRT,HRS,PV,KTCC,
     1A(1001))
      NREADY(3)=1
      IF(NRT.LE.0) NREADY(3)=0
      GO TO 20
  200 CALL BUILD(KIN2,KOUT1,KOUT2,NN,NL,NREG,A,IY)
  260 NREADY(1)=1
      IF(NN.LE.0.OR.NL.LE.0) NREADY(1)=0
      NREADY(2)=0
      NREADY(3)=0
      GO TO 20
  250 CALL EVAC(KOUT1,KOUT2,NN,NL,HRS,PV,NRT,A,Y,S(1001))
      GO TO 20
  300 KS=I-4
      CALL SAVER(KS,NREADY,KIN1,KOUT1,KOUT2,NN,NL,NREG)
      IF(I.EQ.5) GO TO 260
      GO TO 20
  310 WRITE(KOUT1,606)
      READ(KIN1,*,ERR=310) KI
      IF(KI.EQ.KOUT1.OR.KI.EQ.KOUT2.OR.KI.EQ.KOUT3) GO TO 330
      IF(KI.LE.10.AND.KI.NE.5) GO TO 330
      IF(KI.GT.30) GO TO 330
      KIN2=KI
      GO TO 20
  320 WRITE(KOUT1,607)
      READ(KIN1,*,ERR=320) KO
      IF(KO.EQ.KIN1.OR.KO.EQ.KIN2) GO TO 330
      IF(KO.LE.10.AND.KO.NE.6.AND.KO.NE.7) GO TO 330
      IF(I.EQ.9.AND.KO.EQ.KOUT2) GO TO 330
      IF(KO.GT.30) GO TO 330
      IF(I.EQ.8) KOUT2=KO
      IF(I.EQ.9) KOUT3=KO
      GO TO 20
  330 WRITE(KOUT1,610)
      GO TO 310
  606 FORMAT(1X,'INPUT NEW CHANNEL NUMBER (5=TERMINAL)')
  607 FORMAT(1X,'INPUT NEW CHANNEL NUMBER (6=TERMINAL)')
  610 FORMAT(1X,'ILLEGAL CHANNEL SELECTION')
      END
```

```
      SUBROUTINE PASS(KIN1,KOUT1,KOUT2,KOUT3,NN,NL,NPR,NRT,HRS,PV,KTCC,
     1TST)
C ONE PASS
       INCLUDE SOURCE.INSERT
      DIMENSION NPV(4),MPH(4),XPV(4),XPH(4),TST(1)
      DATA YES/'OK'/
      DO 3 L=1,NL
      OMIT(L,1)=.FALSE.
    3 OMIT(L,2)=.FALSE.
```

```
C INPUT NETWORK PARAMETERS
  910 WRITE(KOUT1,606)
  606 FORMAT(/1X,'INPUT VEHICLES/LANE/HOUR FOR 1)LIMITED ACCESS, 2)PRIMA
     1RY 4-LANE, 3)PRIMARY 2-LANE, 4)SECONDARY HIGHWAYS')
      READ(KIN1,*,ERR=910) (NPV(K),K=1,4)
  920 WRITE(KOUT1,608)
  608 FORMAT(1X,'INPUT AVERAGE SPEED IN MILES/HOUR FOR 1)LIMITED ACCESS,
     1 2)PRIMARY 4-LANE, 3)PRIMARY 2-LANE, 4)SECONDARY HIGHWAYS')
      READ(KIN1,*,ERR=920) (MPH(K),K=1,4)
      DO 2 K=1,4
      XPV(K)=NPV(K)
    2 XPH(K)=MPH(K)
      DO 4 L=1,NL
      K1=MFR(L)/10000
      K2=(MFR(L)-10000*K1)/1000
      V=XPV(1)
      T=XPH(1)
      IF(K1.LE.3) GO TO 16
      V=XPV(2)
      T=XPH(2)
      IF(K1.EQ.4) GO TO 16
      V=XPV(3)
      T=XPH(3)
      IF(K1.EQ.5) GO TO 16
      V=XPV(4)
      T=XPH(4)
   16 C=2.0
      IF(K1.EQ.1) C=3.0
      IF(K1.GT.4) C=1.0
      C=V*C
      BFR(L)=C
      SPDLNK(L)=T
      CAPLNK(L)=C
      CFR(L)=DSTLNK(L)/T
      IF(CFR(L).LE.0.0) CFR(L)=0.01
    4 CONTINUE
  360 WRITE(KOUT1,623)
  623 FORMAT(1X,'INPUT HIGHWAY CONFIGURATION CODE 1)NORMAL, 2)ONE WAY, 3
     1)VARIABLE LANES')
      READ(KIN1,*,ERR=360) KTCC
      IF(KTCC.LT.1.OR.KTCC.GT.3) GO TO 360
      IF(KTCC.LE.2) GO TO 370
      DO 365 L=1,NL
  365 BFR(L)=2.0*BFR(L)
  370 WRITE(KOUT1,624)
  624 FORMAT(1X,'INPUT PASSENGERS/VEHICLE X 100')
      READ(KIN1,*,ERR=370) KPV
      IF(KPV.LT.0.OR.KPV.GT.10000) GO TO 370
      PV=FLOAT(KPV)/100.0
  380 WRITE(KOUT1,629)
  629 FORMAT(1X,'INPUT NOMINAL EVACUATION TIME IN HOURS X 100')
      READ(KIN1,*,ERR=380) NH
      HRS=FLOAT(NH)/100.0
      IF(HRS.LT.0.0.OR.HRS.GT.24.) GO TO 380
  390 WRITE(KOUT1,630)
  630 FORMAT(1X,'INPUT DELAY TIME TERMINATION LIMIT IN HOURS X 100')
      READ(KIN1,*,ERR=390) ND
      DTL=FLOAT(ND)/100.0
      IF(2.0*DTL.LT.HRS) DTL=HRS/2.0
      WRITE(KOUT1,650) (XPV(K),XPH(K),K=1,4)
      IF(KTCC.EQ.1) WRITE(KOUT1,651)
      IF(KTCC.EQ.2) WRITE(KOUT1,652)
      IF(KTCC.EQ.3) WRITE(KOUT1,653)
      WRITE(KOUT1,654) PV,HRS,DTL
  650 FORMAT(/1X,'HIGHWAY CLASS   VCLS/LANE/HR  MILES/HOUR'/
     11X,'LIMITED ACCESS  ',F10.0,F12.0,/
     21X,'PRIMARY 4-LANE  ',F10.0,F12.0/
     31X,'PRIMARY 2-LANE  ',F10.0,F12.0/
     41X,'SECONDARY',7X,F10.0,F12.0)
  651 FORMAT(1X,'HIGHWAY CONFIGURATION: NORMAL TWO WAY TRAFFIC')
  652 FORMAT(1X,'HIGHWAY CONFIGURATION: ONE WAY OUTBOUND TRAFFIC')
  653 FORMAT(1X,'HIGHWAY CONFIGURATION: VARIABLE LANES TRAFFIC')
  654 FORMAT(1X,'AVERAGE PASSENGERS PER VEHICLE: ',F5.2/
     11X,'NOMINAL EVACUATION TIME: ',F5.2,' HOURS'/
     21X,'DELAY TIME TERMINATION LIMIT: ',F5.2,' HOURS')
```

```
      IF(KOUT2.EQ.Z) GO TO 400
      CALL HEADER(KOUT2,2.0)
      WRITE(KOUT2,650) (XPV(K),XPH(K),K=1,4)
      IF(KTCC.EQ.1) WRITE(KOUT2,651)
      IF(KTCC.EQ.2) WRITE(KOUT2,652)
      IF(KTCC.EQ.3) WRITE(KOUT2,653)
      WRITE(KOUT2,654) PV,HRS,DTL
      CALL HEADER(KOUT2,2.1)
  400 WRITE(KOUT1,655)
      READ(KIN1,501,ERR=400) AYN
      IF(AYN.NE.YES) GO TO 910
  655 FORMAT(/1X,'TYPE "OK" TO GENERATE ROUTES')
  501 FORMAT(A2)
      NIT=0
      NRT=0
    5 NRS=NRT
      NIT=NIT+1
      NEW=0
    7 NE=0
      DO 30 KPR=1,NPR
      IF(DENPR(KPR).LT.1.0) GO TO 30
      JR=IJPR(1,KPR)
      IF(NE.EQ.0) GO TO 20
      DO 10 JE=1,NE
      IF(JR.EQ.JEV(JE)) GO TO 30
   10 CONTINUE
   20 NE=NE+1
      JEV(NE)=JR
C     WRITE(11,601) NE,JR
  601 FORMAT(1X,2I6)
      CALL PRICE(JR,NN,Y(1,NE),LFR,IFR,MFR,CFR,OMIT(1,2),NODES,IA(1001)
     1,S)
   30 CONTINUE
      CMAX=9999.0
   40 COLD=CMAX
      CMAX=0.0
      KMAX=0
      DO 70 KPR=1,NPR
      IF(DENPR(KPR).LT.1.0) GO TO 70
      JR=IJPR(1,KPR)
      IS=IJPR(2,KPR)
      DO 50 JE=1,NE
      IF(JR.EQ.JEV(JE)) GO TO 60
   50 CONTINUE
      GO TO 70
   60 IF(Y(IS,JE).GT.COLD) GO TO 70
      IF(Y(IS,JE).LE.CMAX) GO TO 70
      CMAX=Y(IS,JE)
      KMAX=KPR
      JMAX=JE
   70 CONTINUE
      IF(KMAX.EQ.0) GO TO 200
      IF(NRT.EQ.500) GO TO 200
      NRT=NRT+1
      DR(NRT)=0.0
      CR(NRT)=CMAX
      IJR(2,NRT)=KMAX
      JR=IJPR(1,KMAX)
      IS=IJPR(2,KMAX)
      CALL ROUTE(IS,JR,IFNO,NRT,IJR,CR,Y(1,JMAX),S,LFR,IFR,MFR,CFR,OMIT(
     11,1),NODES)
      Y(IS,JMAX)=1.0E10
      IF(IFNO.EQ.0) NEW=NEW+1
      IF(IFNO.EQ.0.AND.IFSAME(NRT,NRS,IJR).EQ.0) GO TO 80
   75 NRT=NRT-1
      GO TO 40
   80 IF(NRS.EQ.0) GO TO 40
      TYM=TIMER(NRT,PV,HRS,T1,T2)
      DO 85 KRT=1,NRS
      IF(IJR(2,KRT).EQ.KMAX.AND.TYM.LE.A(KRT)) GO TO 40
   85 CONTINUE
      GO TO 75
```

```
200 IF(NEW.GT.0) GO TO 87
205 LAST=1
    DIV=100.0
    GO TO 125
 87 LAST=0
    IF(NRT.LE.NRS) GO TO 155
    DIV=1.0
    IF(NIT.GT.1) DIV=19.0
120 CALL LOADER(NRT,NL,KTCC)
125 DO 121 KPR=1,NPR
    ISS(KPR+1000)=0
121 TST(KPR)=1.0E20
    DO 130 KRT=1,NRT
    KPR=IJR(2,KRT)
    A(KRT)=TIMER(KRT,PV,HRS,T1,T2)
    S(KRT)=0.0
    IF(TST(KPR).LT.A(KRT)) GO TO 130
    TST(KPR)=A(KRT)
    ISS(KPR+1000) =KRT
130 CONTINUE
    DO 140 KPR=1,NPR
    IF(DENPR(KPR).LT.1.0) GO TO 140
    JRT=ISS(KPR+1000)
    S(JRT)=DENPR(KPR)
140 CONTINUE
    DIV=DIV+1.0
    W1=2.0/DIV
    W2=1.0-W1
    KHG=0
    DO 150 KRT=1,NRT
    IF(ABS(DR(KRT)-S(KRT)).GT.100.0) KHG=KHG+1
150 DR(KRT)=W1*S(KRT)+W2*DR(KRT)
C     WRITE(6,602) (DR(KRT),KRT=1,NRT)
602 FORMAT(1X,10F12.2)
    IF(DIV.GE.500.0) GO TO 175
    IF(KHG.GT.0.AND.DIV.NE.100.0) GO TO 120
    CALL LOADER(NRT,NL,KTCC)
160 DO 131 KPR=1,NPR
131 TST(KPR)=1.0E20
    DO 132 KRT=1,NRT
    KPR=IJR(2,KRT)
    IF(A(KRT).LT.TST(KPR)) TST(KPR)=A(KRT)
132 CONTINUE
    DO 138 KRT=1,NRT
    KPR=IJR(2,KRT)
    IF(DR(KRT).GT.0.02*DENPR(KPR)) GO TO 138
    IF(A(KRT).LT.1.02*TST(KPR)) GO TO 138
133 DRK=DR(KRT)
    DR(KRT)=0.0
    DO 134 JRT=1,NRT
    IF(IJR(2,JRT).NE.KPR) GO TO 134
    DR(JRT)=DR(JRT)+DR(JRT)*DRK/DENPR(KPR)
134 CONTINUE
138 CONTINUE
    NRS=0
    DO 144 KRT=1,NRT
    IF(DR(KRT).EQ.0.0) GO TO 144
    NRS=NRS+1
    DR(NRS)=DR(KRT)
    CR(NRS)=CR(KRT)
    NF=IJR(1,KRT)+1
    DO 142 J=1,NF
142 IJR(J,NRS)=IJR(J,KRT)
144 CONTINUE
    NRT=NRS
    CALL LOADER(NRT,NL,KTCC)
    IF(LAST.GT.0) GO TO 175
155 CALL BLOCK(KOUT1,KOUT2,NN,NL,KTCC,PV,HRS,T1,NIT,NRT)
    IF(T1.LE.2.0*DTL+.001.OR.NRT.EQ.500) GO TO 205
    GO TO 5
175 CALL SHOW(KOUT2,KOUT3,NPR,NRT,NE,PV,HRS,A)
    RETURN
    END
```

```
      SUBROUTINE ORDER(NN,NL,LFR,IFR,JTO,MFR,CFR,ISS,ID)
C REORDER LINK LIST
      DIMENSION LFR(1),IFR(1),JTO(1),MFR(1),CFR(1),ISS(1),ID(1)
C     CALL TIME(0)
      DO 10 K=1,NL
   10 ID(K)=100000*JTO(K)+MFR(K)
      CALL SORTR(NL,ID,LFR,ISS)
      DO 20 K=1,NL
C     WRITE(9,600) K,LFR(K),IFR(K),JTO(K),MFR(K),CFR(K),ID(K)
  600 FORMAT(1X,5I6,F10.3,I10)
      K0=LFR(K)
   20 ISS(K0)=K
      DO 30 K=1,NL
      I0=IFR(K)
      J0=JTO(K)
      M0=MFR(K)
      C0=CFR(K)
      K0=LFR(K)
      IFR(K)=IFR(K0)
      JTO(K)=JTO(K0)
      MFR(K)=MFR(K0)
      CFR(K)=CFR(K0)
      IFR(K0)=I0
      JTO(K0)=J0
      MFR(K0)=M0
      CFR(K0)=C0
      K1=ISS(K)
      ISS(K0)=K1
   30 LFR(K1)=K0
      DO 35 K=1,NN
   35 LFR(K)=0
      J=0
      DO 40 K=1,NL
      IF(JTO(K).EQ.J) GO TO 40
      J=JTO(K)
C     LFR(J)=K
   40 CONTINUE
      N1=NN+1
      N2=N1+1
      LFR(N1)=NL+1
      DO 50 K=1,N1
      K1=N2-K
      IF(LFR(K1).EQ.0) LFR(K1)=J
   50 J=LFR(K1)
      DO 80 K=1,NL
      I1=IFR(K)
      ISS(K)=0
      I2=JTO(K)
      LS=LFR(I1)
      LF=LFR(I1+1)-1
      DO 60 L=LS,LF
      IF(IFR(L).EQ.I2.AND.MFR(L).EQ.MFR(K)) GO TO 70
   60 CONTINUE
      GO TO 80
   70 ISS(K)=L
   80 CONTINUE
      DO 90 K=1,NL
      L=ISS(K)
C       WRITE(6,601)
C K,LFR(K),IFR(K),JTO(K),ISS(K),MFR(K),IFR(L),JTO(L),ISS(L),MFR(L)
  601 FORMAT(1X,10I6)
   90 JTO(K)=ISS(K)
      RETURN
      END
```

```
      SUBROUTINE PRICE(JR,NN,Y,LFR,IFR,MFR,CFR,OMIT,NODES,ISS,S)
C PRICE OUT NODES FOR TRAFFIC TO JR
      LOGICAL OMIT
      DIMENSION Y(1),LFR(1),IFR(1),MFR(1),CFR(1),OMIT(1),ISS(2,1),S(1),N
     1ODES(3,1)
      DO 10 I=1,NN
      S(I)=99999.99
      ISS(1,I)=I
      ISS(2,I)=I
   10 CONTINUE
      S(1)=0.0
      ISS(1,JR)=1
      ISS(1,1)=JR
      ISS(2,1)=JR
      ISS(2,JR)=1
      DO 50 I=2,NN
      I1=I-1
      IF(S(I1).GT.99999.) GO TO 60
      IT=ISS(2,I1)
      KS=LFR(IT)
      KF=LFR(IT+1)-1
      IF(KS.GT.KF) GO TO 25
      DO 20 K=KS,KF
      IK=IFR(K)
      JK=ISS(1,IK)
  600 FORMAT(1X,5I5,3F9.3,4I6)
      IF(JK.LT.I) GO TO 20
      P=S(I1)+CFR(K)
      IF(P.GE.S(JK)) GO TO 20
      IF(OMIT(K)) GO TO 20
C      WRITE(11,600)
C IK,IT,MFR(K),JK,I,CFR(K),S(I1),S(JK),NODES(1,IK),NODES(1,IT),NODES(1,J
C K),NODES(1,I)
   15 S(JK)=P
   20 CONTINUE
   25 IF(I.GE.NN) GO TO 60
   30 JS=I+1
      J=I
      P=S(I)
      DO 40 J1=JS,NN
      IF(S(J1).GE.P) GO TO 40
      P=S(J1)
      J=J1
   40 CONTINUE
      S(J)=S(I)
      S(I)=P
      N=ISS(2,J)
      ISS(2,J)=ISS(2,I)
      ISS(2,I)=N
      ISS(1,N)=I
      N=ISS(2,J)
      ISS(1,N)=J
   50 CONTINUE
   60 DO 70 I=1,NN
      IY=ISS(2,I)
   70 Y(IY)=S(I)
C     WRITE(11,601) (Y(I),I=1,NN)
  601 FORMAT(1X,10E12.4)
      RETURN
      END
```

```
      SUBROUTINE ROUTE(IS,JR,IFNO,KR,IJR,CR,Y,S,LTO,JTO,MTO,CTO,OMIT,NOD
     1ES)
C FIND THE BEST DISTINCT ROUTE FROM IS TO JR
      LOGICAL OMIT
      DIMENSION IJR(21,1),CR(1),Y(1),S(1)
      DIMENSION LTO(1),JTO(1),MTO(1),CTO(1),OMIT(1),NODES(3,1)
      DATA LIM,TOL/19,1.001/
C     DO 5 L=1,407
C     J=JTO(L)
C     NJ=10000*NODES(1,J)+10*NODES(2,J)+NODES(3,J)
C     WRITE(6,602) L,LTO(L),LTO(L+1),J,NJ,MTO(L),CTO(L),BTO(L),Y(J)
C   5 CONTINUE
C     WRITE(6,602) KR,IS,JR
```

```
      IFNO=0
      IJR(1,KR)=1
      J=IS
      CR(KR)=Y(IS)
      CTEST=Y(IS)*TOL
      S(KR)=0.0
   10 IL=IJR(1,KR)
      IF(Y(IS).GT.99999.0) GO TO 70
   20 I=J
      IF(I.NE.JR.AND.IL.LE.LIM) GO TO 30
C     WRITE(6,600) KR,CR(KR),S(KR),MTO(L),(IJR(1,K+1,KR),K=1,IL)
      IF(IL.GT.LIM) GO TO 70
      RETURN
   30 CKR=S(KR)
      LS=LTO(I)
      LF=LTO(I+1)-1
      DO 50 L=LS,LF
      IF(OMIT(L)) GO TO 50
      J=JTO(L)
C     WRITE(6,602) I,J,IS,JR,L,MTO(L),CKR,CTO(L),Y(J),Y(IS),Y(JR)
  602 FORMAT(1X,6I9,5F9.3)
      IF(CKR+CTO(L)+Y(J).LT.CTEST) GO TO 55
   50 CONTINUE
   70 IFNO=1
C     WRITE(6,602) I,J,IS,JR,L,MTO(L),CKR,CTO(L),Y(J),Y(IS),Y(JR)
      RETURN
   55 IJR(1,KR)=IL+1
      IJR(IL+2,KR)=L
      S(KR)=CKR+CTO(L)
      CR(KR)=S(KR)+Y(J)
      IL=IL+1
C     WRITE(10,600) KR,CR(KR),S(KR),MTO(L),(IJR(1,K+1,KR),K=1,IL)
  600 FORMAT(1X,I5,2F9.3,20I5/(25X,20I5))
      GO TO 20
      END
```

```
      SUBROUTINE COUNTY(KOUT2,NN,XLLOC,LLOC,NODES,ANAMES)
C LIST POPULATION CENTROIDS
      DIMENSION XLLOC(2,1),LLOC(1),NODES(3,1),ANAMES(7,1),ALPH(6)
      DATA ALPH/'A','B','C','D',' ','X'/
      IF(KOUT2.NE.6) CALL HEADER(KOUT2,4,1)
      WRITE(KOUT2,601)
      DO 10 J=1,NN
      IF(NODES(3,J).GT.0) GO TO 10
      K=1000*NODES(1,J)+2*NODES(2,J)-1
      POP=XLLOC(1,J)
      AR=XLLOC(2,J)
      DEN=POP/AR
      L1=LLOC(J)/10
      IF(L1.EQ.0) L1=5
      L2=LLOC(J)-10*L1+5
      AL=ALPH(L1)
      CF=ALPH(L2)
      WRITE(KOUT2,602) K,(ANAMES(I,J),I=1,7),POP,AR,DEN,AL,CF
   10 CONTINUE
      RETURN
  602 FORMAT(1X,I5,2X,4A4,2X,3A4,F12.0,2F8.0,3X,A1,1X,A1)
  601 FORMAT(/1X,'POPULATION CENTROID LIST'/
     11X,'FIPS   PLACE NAME',8X,'COUNTY',8X,'POPULATION   AREA',
     2'  DENSITY  FEMA')
      END
```

```
      SUBROUTINE STACK(NET,NREG,MAP,KIN1,KOUT1,KOUT2,NN,NOLOC,XLLOC,
     1LLOC,NODES,ANAMES)
C BUILD NETWORK NODE LISTS FROM NODELIST FILE
      DIMENSION NOLOC(2,1),XLLOC(2,1),NODES(3,1),ANAMES(7,1),LLOC(1)
      DIMENSION NET(1),NREG(1),MAP(4,1)
      DEFINE FILE 8(4000,100,E,NR)
      DO 10 I=1,500
      XLLOC(1,I)=0
      XLLOC(2,I)=0
   10 CONTINUE
      J0=0
      K=0
      DO 40 J=1,60
      IF(MAP(1,J).EQ.0.OR.NREG(J).EQ.0) GO TO 40
      NR=MAP(1,J)
      FIND (8'NR)
      NF=MAP(2,J)
      IF(J0.GT.0) NOLOC(2,J0)=K
      NOLOC(1,J)=K+1
      J0=J
      NNS=NF-NR+1
      WRITE(KOUT1,601) NNS,J
  601 FORMAT(1X,'READING ',I3,' NODES FOR STATE ',I2)
      DO 30 JR=NR,NF
      K=K+1
      IF(K.GT.500) GO TO 50
      READ (8'NR,502,ERR=20) IT,IC,IO,(ANAMES(I,K),I=1,7),XIP,
     1XIA,IX
      IC=(IC+1)/2
      XLLOC(1,K)=XIP
      XLLOC(2,K)=XIA
      LLOC(K)=IX
      NODES(1,K)=IT
      NODES(2,K)=IC
      NODES(3,K)=IO
      GO TO 30
   20 WRITE(6,602) J,JR
  602 FORMAT(1X,2I5)
      K=K-1
   30 CONTINUE
   40 CONTINUE
      NN=K
      NOLOC(2,J0)=NN
      RETURN
   50 NN=-1
      WRITE(6,603)
  603 FORMAT(1X,'NUMBER OF NODES EXCEEDS 500')
      RETURN
  501 FORMAT(A1,I5,2X,5A4,I3)
  502 FORMAT(I2,I3,4X,I1,12X,4A4,26X,3A4,2X,2F8.0,4X,I2)
  503 FORMAT(1X,3I8,2F8.0,2I8)
      END
```

```
      FUNCTION LOCK(IT,IC,IO,NOLOC,NODES)
C FIND NODE INDEX
      DIMENSION NOLOC(2,1),NODES(3,1)
      KS=NOLOC(1,IT)
      KF=NOLOC(2,IT)
      DO 10 K=KS,KF
      IF(NODES(2,K).NE.IC) GO TO 10
      IF(NODES(3,K).NE.IO) GO TO 10
      LOCK=K
      RETURN
   10 CONTINUE
      LOCK=0
      WRITE(6,601) IT,IC,IO,NOLOC(1,IT),NOLOC(2,IT)
  601 FORMAT(1X,'NODE LOCATION ERROR',5I5)
      RETURN
      END
```

```
      SUBROUTINE ROADS(NET,NREG,MAP,KOUT1,NN,NL,CIJ,IJ,NOLOC,NODES)
C CONSTRUCT ROAD LINKS FROM ROADNET FILE
      DIMENSION CIJ(1),IJ(3,1),NOLOC(2,1),NODES(3,1)
      DIMENSION NET(1),NREG(1),MAP(4,1)
      DEFINE FILE 9(10000,100,E,NR)
      NL=0
      DO 40 J=1,60
      IF(MAP(3,J).EQ.0.OR.NREG(J).EQ.0) GO TO 40
      NR=MAP(3,J)
      FIND (9'NR)
      NF=MAP(4,J)
      NNS=2*(NF-NR+1)
      WRITE(KOUT1,601) NNS,J
  601 FORMAT(1X,'READING ',I3,' LINKS FOR STATE ',I2)
      DO 30 JR=NR,NF
      READ (9'NR,503,ERR=25) IT,IC,IO,L1,L2,JT,JC,JO,L3,L4,K1,K2,JH
      IS=NREG(IT)
      JS=NREG(JT)
      IF(IS.EQ.0.OR.JS.EQ.0) GO TO 30
      IC=(IC+1)/2
      JC=(JC+1)/2
      IO=IO+1
      JO=JO+1
      D=((L1-L3)*(L1-L3)+(L2-L4)*(L2-L4))**.5
      I1=LOCK(IT,IC,IO-1,NOLOC,NODES)
      J1=LOCK(JT,JC,JO-1,NOLOC,NODES)
      IF(I1.EQ.0.OR.J1.EQ.0) GO TO 30
      KODE=1000*K1+JH+10000*(K2-1)
      IF(IT.EQ.JT) GO TO 18
      DO 10 L=1,NL
      IF(I1.NE.IJ(1,L)) GO TO 10
      IF(J1.NE.IJ(2,L)) GO TO 10
      IF(KODE.NE.IJ(3,L)) GO TO 10
      GO TO 30
   10 CONTINUE
   18 NL=NL+1
      IJ(1,NL)=I1
      IJ(2,NL)=J1
      IJ(3,NL)=KODE
      CIJ(NL)=D
      NL=NL+1
      IJ(1,NL)=IJ(2,NL-1)
      IJ(2,NL)=IJ(1,NL-1)
      IJ(3,NL)=IJ(3,NL-1)
      CIJ(NL)=D
      GO TO 30
   25 WRITE(6,602) J,JR
  602 FORMAT(1X,2I5)
   30 CONTINUE
   40 CONTINUE
  502 FORMAT(2X,I3,I2,2I5,3X,I3,I2,2I5,1X,2I1,I5)
  503 FORMAT(I2,I3,I2,2I5,1X,I2,I3,I2,2I5,1X,2I1,I5)
      RETURN
      END
```

```
      SUBROUTINE SAVER(KFLAG,NREADY,KIN1,KOUT1,KOUT2,NN,NL,NREG)
C SAVE OR RETRIEVE ORDERED ARRAYS TO BYPASS ORDERING
       INCLUDE SOURCE.INSERT
      DIMENSION NREG(1)
      DATA YES/'YES'/
      NREADY=0
      IF(KFLAG.EQ.0) RETURN
      IF(KFLAG.EQ.2) GO TO 100
    5 WRITE(KOUT1,601)
      READ(KIN1,*,ERR=5) IFILE
      IF(IFILE.LT.11.OR.IFILE.GT.30) GO TO 10
      REWIND IFILE
      READ(IFILE,ERR=200) NN,NL,(NREG(K),K=1,60),((NOLOC(I,J),I=1,2)
     1,J=1,60)
      READ(IFILE,ERR=200) (LFR(K),K=1,NN),LFR(NN+1)
```

```
      READ(IFILE,ERR=200) (IFR(J),J=1,NL)
      READ(IFILE,ERR=200) (JTO(J),J=1,NL)
      READ(IFILE,ERR=200) (MFR(J),J=1,NL)
      READ(IFILE,ERR=200) (DSTLNK(J),J=1,NL)
      READ(IFILE,ERR=200) ((XLLOC(J,K),K=1,NN),J=1,2),(LLOC(K),K=1,NN)
      READ(IFILE,ERR=200) ((NODES(I,K),K=1,NN),I=1,3)
      READ(IFILE,ERR=200) ((ANAMES(I,K),K=1,NN),I=1,7)
      WRITE(KOUT1,651)
      DO 10 K=1,60
      IF(NREG(K).EQ.0) GO TO 10
      WRITE(KOUT1,652) K,(SNAMES(I,K),I=1,4)
   10 CONTINUE
  651 FORMAT(/1X,'NUMBER  STATE NAME')
  652 FORMAT(1X,I4,4X,4A4)
      WRITE(KOUT1,600) NN,NL
      REWIND IFILE
      NREADY=1
      IF(KOUT2.EQ.6) GO TO 30
      CALL HEADER(KOUT2,5.0)
      WRITE(KOUT2,651)
      DO 20 K=1,60
      IF(NREG(K).EQ.0) GO TO 20
      WRITE(KOUT2,652) K,(SNAMES(I,K),I=1,4)
   20 CONTINUE
      WRITE(KOUT2,600) NN,NL
   30 WRITE(KOUT1,604)
  604 FORMAT(/1X,'LIST THE POPULATION CENTROIDS (YES OR NO)?')
      READ(KIN1,501) AYN
      IF(AYN.EQ.YES) CALL COUNTY(KOUT2,NN,XLLOC,LLOC,NODES,ANAMES)
  501 FORMAT(A3)
      RETURN
  100 WRITE(KOUT1,602)
      READ(KIN1,*,ERR=100) IFILE
      IF(IFILE.LT.11.OR.IFILE.GT.30) GO TO 100
      REWIND IFILE
      WRITE(IFILE) NN,NL,(NREG(K),K=1,60),((NOLOC(I,J),I=1,2),J=1,60)
      WRITE(IFILE) (LFR(K),K=1,NN),LFR(NN+1)
      WRITE(IFILE) (IFR(J),J=1,NL)
      WRITE(IFILE) (JTO(J),J=1,NL)
      WRITE(IFILE) (MFR(J),J=1,NL)
      WRITE(IFILE) (DSTLNK(J),J=1,NL)
      WRITE(IFILE) ((XLLOC(J,K),K=1,NN),J=1,2),(LLOC(K),K=1,NN)
      WRITE(IFILE) ((NODES(I,K),K=1,NN),I=1,3)
      WRITE(IFILE) ((ANAMES(I,K),K=1,NN),I=1,7)
  600 FORMAT(/1X,'NUMBER OF NETWORK NODES       ',I5/1X,'NUMBER OF NETWOR
     1K LINKS         ',I5)
  601 FORMAT(1X,'ASSIGN INPUT CHANNEL FOR SAVED NETWORK')
  602 FORMAT(1X,'ASSIGN OUTPUT CHANNEL FOR SAVED NETWORK')
      ENDFILE IFILE
      NREADY=1
      RETURN
  200 WRITE(KOUT1,603)
  603 FORMAT(1X,'FILE ERROR NETWORK READ CANCELLED')
      RETURN
      END
```

```
      SUBROUTINE SHOW(KOUT1,IFILE,NPR,NRT,NE,PV,HRS,XL)
C DISPLAY A ROUTE
       INCLUDE SOURCE.INSERT
      DIMENSION XL(21,1)
      IF(KOUT1.EQ.6) GO TO 1
      CALL HEADER(KOUT1,2.2)
    1 CALL HEADER(IFILE,2.3)
      WRITE(KOUT1,601)
      DO 210 KPR=1,NPR
      DO 200 JRT=1,NRT
      IF(IJR(2,JRT).NE.KPR) GO TO 200
      DO 2 J=1,21
    2 XL(J,JRT)=0.0
      IF(DR(JRT).LT.100.0) GO TO 200
      WRITE(IFILE,609) JRT
      WRITE(IFILE,606)
      WRITE(IFILE,610)
```

```
  100 NF=IJR(1,JRT)+1
C     WRITE(6,666) JRT,(IJR(1,K,JRT),K=1,NF),(IJR(2,K,JRT),K=1,NF)
  666 FORMAT(1X,10I5)
C     GO TO 100
    8 L=IJR(NF,JRT)
      I=IFR(L)
      NODE=10000*NODES(1,I)+10*(2*NODES(2,I)-1)+NODES(3,I)
      NON=I
      NO1=NON
      CAP=0.0
      USE=0.0
      STOT=0.0
      DTOT=0.0
      SPD=0.0
      VCL=0.0
      TIM=HRS/2.0
      TOT=TIM
      MODE=MFR(L)+10000
C     WRITE(IFILE,600) NODE,MODE,STOT,DTOT,SPD,(ANAMES(K,NON),K=1,5)
      MR=0
      T=0.0
      J=1
    5 J=J+1
      NJ=NF-J+2
      IF(J.EQ.2) GO TO 25
   10 L=IJR(NJ+1,JRT)
      IF(NJ.EQ.2) GO TO 12
      LO=IJR(NJ,JRT)
      I=IFR(LO)
      GO TO 20
   12 I=IJPR(2,KPR)
   20 DST=DSTLNK(L)
      SPD=SPDLNK(L)
      CAP=BFR(L)
   15 T=T+DST/ABS(SPD)
   24 STOT=T
      DTOT=DTOT+DST
      SPD=ABS(SPD)
      VCL=DFR(L)/PV
      TYM=VCL/(2.0*CAP)
      IF(TYM.GT.TIM) TIM=TYM
      TOT=STOT+TIM
      NODE=10000*NODES(1,I)+10*(2*NODES(2,I)-1)+NODES(3,I)
      NON=I
   25 CONTINUE
      XL(NJ,JRT)=STOT
      NH=MFR(L)-1000*(MFR(L)/1000)
      KH=MFR(L)/10000+1
      MODE=MFR(L)+10000
      IF(KH.EQ.1) WRITE(IFILE,604) NODE,MODE,STOT,TIM,TOT,DTOT,SPD,CAP,
     1VCL,(ANAMES(K,NON),K=1,7),NH
      IF(KH.EQ.2) WRITE(IFILE,603) NODE,MODE,STOT,TIM,TOT,DTOT,SPD,CAP,
     1VCL,(ANAMES(K,NON),K=1,7),NH
      IF(KH.EQ.3) WRITE(IFILE,602) NODE,MODE,STOT,TIM,TOT,DTOT,SPD,CAP,
     1VCL,(ANAMES(K,NON),K=1,7),NH
   30 IF(J.LT.NF) GO TO 5
      XL(2,JRT)=STOT
C  60 WRITE(IFILE,605) NODE,MODE,STOT,TIM,TOT,DTOT,SPD,(ANAMES(K,NON),K=1,5)
      WRITE(IFILE,606)
  606 FORMAT(1X)
      T3=TIMER(JRT,PV,HRS,T1,T2)
      WRITE(KOUT1,620) JRT,IJR(2,JRT),DR(JRT),(ANAMES(K,NO1),K=1,7),(A
     1NAMES(K,NON),K=1,7),DTOT,T1,T2,T3
  620 FORMAT(1X,I5,2X,I4,2X,F10.0,3X,7A4,4X,7A4,2X,F8.1,3(2X,F8.2))
  200 CONTINUE
  210 CONTINUE
      RETURN
  604 FORMAT(1X,I6,2X,I5,3F8.2,2F8.1,2F8.0,3X,7A4,'     INTERSTATE '
     1,I3)
  603 FORMAT(1X,I6,2X,I5,3F8.2,2F8.1,2F8.0,3X,7A4,'     U.S. ROUTE '
     1,I3)
  602 FORMAT(1X,I6,2X,I5,3F8.2,2F8.1,2F8.0,3X,7A4,'     STATE ROAD '
     1,I3)
  609 FORMAT(/1X,'ROUTE',I4)
  610 FORMAT(1X,'NODE    CODE    TRAVEL  DELAY   TOTAL   DIST.   SPEED',
     1'    CAP.   VCLS    PLACE NAME',6X,'COUNTY',9X,'   ROUTE NAME')
  601 FORMAT(/1X,'ROUTE CHARACTERISTICS AND LOADINGS'/27X,'FROM',28X,'TO
     1',42X,'AVERAGE HOURS'/1X,'ROUTE  PAIR    EVACUEES    ','CITY',12X,'
     2COUNTY',10X,'CITY',12X,'COUNTY',6X,'  DISTANCE    TRAVEL     DELAY
     3     TOTAL')
      END
```

```
      SUBROUTINE SORTR(N,IDAT,INDX,L)
      INTEGER INDX,L
      DIMENSION IDAT(1),INDX(1)
      DIMENSION L(1)
      K1=0
      I=0
      M1=0
      T2=0
      T4=0
      J=N+1
      L(1)=1
      L(J)=1
      K2=1
      IF(N.LE.1) GO TO 940
      S1=N
C CLIMB THE TREE
  250 IF(S1.LT.4) GO TO 320
      K2=K2*2
      B2=S1/2.
      S1=IFIX(B2)
      T4=T4+(B2-S1)*K2
      GO TO 250
C INITIAL CALCULATIONS
  320 T4=K2-T4
      B2=K2/2
C NEXT TWIG
  350 IF(K1.EQ.K2) GO TO 940
      T1=K1+1
      K1=K1+1
      B1=B2
      T3=T2
C ADD 1 TO REFLECTED BINARY COUNTER AND CARRY
  400 T1=T1/2.
      IF(IFIX(T1).LT.T1) GO TO 470
      M1=M1+1
      T2=T2-B1
      B1=B1/2.
      GO TO 400
C TWIG CALCULATIONS
  470 T2=T2+B1
      IF(S1.EQ.2.) GO TO 550
C 3-TWIGS & 4-TWIGS
      IF(T3.LT.T4) GO TO 560
C 4-TWIG
      M1=-1*M1
      GO TO 630
  550 IF(T3.LT.T4) GO TO 610
C ...3-TWIG
  560 M1=M1+1
      I=I+1
      L(I)=I
      L(J)=I
      J=J+1
C ...2-TWIG
  610 M1=M1+1
  630 I=I+1
      L1=I
      L(I)=I
      L(J)=I
      L0=J
      J=J+1
      I=I+1
      L2=I
      L(I)=I
      L(J)=I
      GO TO 750
C MERGE LEAVES AND BRANCHES
  700 J=J-1
      L0=J-1
      L1=L(L0)
      L2=L(J)
  750 IF(IDAT(L1).LE.IDAT(L2)) GO TO 820
      L(L0)=L2
  770 L0=L2
      L2=L(L0)
      IF(L2.EQ.L0) GO TO 870
      IF(IDAT(L1).GT.IDAT(L2)) GO TO 770
      L(L0)=L1
  820 L0=L1
      L1=L(L0)
      IF(L1.NE.L0) GO TO 750
```

```
      L(LO)=L2
      GO TO 880
  870 L(LO)=L1
  880 M1=M1-1
      IF(M1.GT.0) GO TO 700
      IF(M1.EQ.0) GO TO 350
C GENERATE 2ND HALF OF A 4-TWIG
      M1=1-M1
      GO TO 630
C EXIT
  940 LO=N+1
      DO 1030 I=1,N
      LJ=L(LO)
      INDX(I)=LJ
 1030 CONTINUE
      RETURN
      END


      SUBROUTINE BUILD(KIN1,KOUT1,KOUT2,NN,NL,NREG,CIJ,IJ)
C ASSEMBLE NETWORK COMPONENTS AND SORT LINKS
       INCLUDE SOURCE.INSERT
      DIMENSION CIJ(1),IJ(3,1)
      DIMENSION NET(60),NREG(1)
      DATA OK,YES,YS/'OK','YES','Y'/
   70 WRITE(KOUT1,603)
  603 FORMAT(/' INPUT THE NUMBER OF STATES IN THE REGION (UP TO 10)')
      READ(KIN1,*,ERR=70) NS
      IF(NS.LT.1.OR.NS.GT.10) GO TO 70
      WRITE(KOUT1,602) NS
  602 FORMAT(1X,'INPUT ',I2,' STATE NUMBERS')
      READ(KIN1,*,ERR=70) (JEV(K),K=1,NS)
      DO 80 K=1,NS
      IF(JEV(K).LT.1.OR.JEV(K).GT.99) GO TO 70
   80 CONTINUE
  110 DO 120 I=1,60
  120 NREG(I)=0
      WRITE(KOUT1,601)
      DO 130 K=1,NS
      I=JEV(K)
      WRITE(KOUT1,606) I,(SNAMES(J,I),J=1,4)
  130 NREG(I)=K
      WRITE(KOUT1,607)
      READ(KIN1,501) AYN
      IF(AYN.NE.OK) GO TO 70
  170 CALL STACK(NET,NREG,MAP,KIN1,KOUT1,KOUT2,NN,NOLOC,XLLOC,LLOC,
     1NODES,ANAMES)
      IF(NN.LE.0) RETURN
      CALL ROADS(NET,NREG,MAP,KOUT1,NN,NL,CIJ,IJ,NOLOC,NODES)
      IF(NL.LE.0) RETURN
      WRITE(KOUT1,604) NN
      WRITE(KOUT1,605) NL
  604 FORMAT(/' NUMBER OF NETWORK NODES       ',I5)
  605 FORMAT(' NUMBER OF NETWORK LINKS       ',I5)
      IF(KOUT2.EQ.6) GO TO 200
      CALL HEADER(KOUT2,4.0)
      WRITE(KOUT2,601)
      DO 190 K=1,NS
      I=JEV(K)
  190 WRITE(KOUT2,606) I,(SNAMES(J,I),J=1,4)
      WRITE(KOUT2,604) NN
      WRITE(KOUT2,605) NL
  200 DO 210 L=1,NL
      IFR(L)=IJ(1,L)
      JTO(L)=IJ(2,L)
      MFR(L)=IJ(3,L)
  210 DSTLNK(L)=CIJ(L)
      CALL ORDER(NN,NL,LFR,IFR,JTO,MFR,DSTLNK,IA,IY)
      WRITE(KOUT1,608)
      READ(KIN1,504) AYN
      IF(AYN.EQ.YES.OR.AYN.EQ.YS) CALL COUNTY
     1(KOUT2,NN,XLLOC,LLOC,NODES,ANAMES)
  504 FORMAT(A3)
  608 FORMAT(/1X,'LIST THE POPULATION CENTROIDS (YES OR NO)' )
      RETURN
  601 FORMAT(/1X,'NUMBER  STATE NAME')
  606 FORMAT(1X,I4,4X,4A4)
  607 FORMAT(/1X,'TYPE "OK" TO ASSEMBLE NETWORK')
  501 FORMAT(A2)
      END
```

```
      SUBROUTINE SETUP(KOUT1,KOUT2,KIN1,NN,NL,NREG,NPR,INFS)
      LOGICAL B
      REAL*8 Z,P,R,X0
      DIMENSION SV(100),DV(500),Z(600),IV(500),JV(500),JR(500),JE(100),P
     1(100),R(500),B(5000)
       INCLUDE SOURCE.INSERT
      DIMENSION NREG(1)
      DATA YES,OK,YS/'YES','OK','Y'/
      DO 5 L=1,NL
      OMIT(L,1)=.FALSE.
      OMIT(L,2)=.FALSE.
      K1=MFR(L)/10000
      K1=(MFR(L)-10000*K1)/1000
      T=55.0
      IF(K1.EQ.4) T=45.0
      IF(K1.EQ.5) T=40.0
      IF(K1.GT.5) T=30.0
      SPDLNK(L)=T
      CFR(L)=DSTLNK(L)/T
      IF(CFR(L).LE.0.0) CFR(L)=0.01
    5 CONTINUE
      KGE=0
      KGR=0
      K1=0
  200 WRITE(KOUT1,611)
  611 FORMAT(/,1X,'INPUT EVACUATION PLAN (YES OR NO)?')
      READ(KIN1,511,ERR=200) AYN
  511 FORMAT(A3)
      IF(AYN.NE.YES.AND.AYN.NE.YS) GO TO 220
      WRITE(KOUT1,612)
  612 FORMAT(1X,'FOR EACH PAIR INPUT: EVACUATION COUNTY NO., RECEPTION C
     1OUNTY NO., NUMBER OF PEOPLE')
      NPR=1
      NE=0
  205 NPR=NPR-1
      IF(NPR.LT.0) NPR=0
  210 CONTINUE
      READ(KIN1,*,ERR=210) I1,J1,NUM
      IF(I1.EQ.999) GO TO 125
      IF(I1.LE.0) GO TO 205
      NPR=NPR+1
      S(NPR)=0.0
      IT=I1/1000
      IC=(I1-1000*IT+1)/2
      IJPR(1,NPR)=LOCK(IT,IC,0,NOLOC,NODES)
      I1=IJPR(1,NPR)
      IT=J1/1000
      IC=(J1-1000*IT+1)/2
      IJPR(2,NPR)=LOCK(IT,IC,0,NOLOC,NODES)
      J1=IJPR(2,NPR)
      DENPR(NPR)=NUM
      IF(I1.EQ.0.OR.J1.EQ.0) GO TO 215
      WRITE(KOUT1,605) NPR,DENPR(NPR),(ANAMES(K,I1),K=1,7),(ANAMES(K,J1)
     1,K=1,7)
      DO 212 IE=1,NE
      IF(JE(IE).EQ.I1) GO TO 214
  212 CONTINUE
      NE=NE+1
      JE(NE)=I1
      CALL PRICE(I1,NN,Y(1,NE),LFR,IFR,MFR,CFR,OMIT,NODES,IA,S)
      IE=NE
  214 S(NPR)=Y(J1,IE)
      GO TO 210
  215 WRITE(KOUT1,651)
  651 FORMAT(1X,'COUNTY NOT IN NETWORK')
      GO TO 205
  220 WRITE(KOUT1,613)
  613 FORMAT(1X,'SPECIFY EVACUATION COUNTIES (YES OR NO)?')
      READ(KIN1,511,ERR=220) AYN
      IF(AYN.NE.YES.AND.AYN.NE.YS) GO TO 240
      WRITE(KOUT1,614)
  614 FORMAT(1X,'FOR EACH EVACUATION COUNTY INPUT: COUNTY NO., NUMBER'
     1,' OF PEOPLE')
```

```
      NE=1
      KOE=1
  225 NE=NE-1
      IF(NE.LT.0) NE=0
  230 CONTINUE
      READ(KIN1,*,ERR=230) I1,NUM
      IF(I1.EQ.999) GO TO 280
      IF(I1.LE.0) GO TO 225
      NE=NE+1
      IT=I1/1000
      IC=(I1-1000*IT+1)/2
      J=LOCK(IT,IC,0,NOLOC,NODES)
      JE(NE)=J
      SV(NE)=-NUM
      SVN=NUM
      IF(J.EQ.0) GO TO 235
      WRITE(KOUT1,605) NE,SVN,(ANAMES(K,J),K=1,7)
      CALL PRICE(J,NN,Y(1,NE),LFR,IFR,MFR,CFR,OMIT,NODES,IA,S)
      GO TO 230
  235 WRITE(KOUT1,651)
      GO TO 225
  240 WRITE(KOUT1,615)
  615 FORMAT(1X,'INPUT VULNERABILITY GROUP CODE (1 TO 4)')
      READ(KIN1,*,ERR=240) KV
      IF(KV.LT.1.OR.KV.GT.4) GO TO 240
  245 WRITE(KOUT1,641)
  641 FORMAT(1X,'INPUT MINIMUM PERCENT TO BE EVACUATED')
      READ(KIN1,*,ERR=245) KPV
      IF(KPV.LT.0.OR.KPV.GT.100) GO TO 245
      PEV=FLOAT(KPV)/100.0
  250 WRITE(KOUT1,616)
  616 FORMAT(1X,'EVACUATE COUNTERFORCE TARGETS (YES OR NO)?')
      READ(KIN1,511,ERR=250) AYN
      IF(AYN.EQ.YES.OR.AYN.EQ.YS) KF=1
      NE=0
      DO 270 J=1,NN
      IF(XLLOC(2,J).LE.0.0) GO TO 270
      JW=LLOC(J)/10
      JF=LLOC(J)-10*JW
      IF(JW.EQ.1.AND.KV.EQ.1) GO TO 260
      IF(JW.GT.1.AND.JW.LE.KV) GO TO 260
      IF(JF.GT.0.AND.KF.EQ.1) GO TO 260
      GO TO 270
  260 NE=NE+1
      JE(NE)=J
      SV(NE)=XLLOC(1,J)*PEV
      IF(JF.GT.0.AND.KF.EQ.1) SV(NE)=-SV(NE)
      CALL PRICE(J,NN,Y(1,NE),LFR,IFR,MFR,CFR,OMIT,NODES,IA,S)
  270 CONTINUE
      EMAX=1.0E10
  390 WRITE(KOUT1,626)
  626 FORMAT(1X,'INPUT POST EVACUATION MAXIMUM DENSITY IN EVACUATED COUN
     1TIES IN PEOPLE/SQ. MILE')
      READ(KIN1,*,ERR=390) MAXE
      EMAX=MAXE
  280 WRITE(KOUT1,617)
  617 FORMAT(1X,'SPECIFY RECEPTION COUNTIES (YES OR NO)?')
      READ(KIN1,511,ERR=280) AYN
      IF(AYN.NE.YES.AND.AYN.NE.YS) GO TO 310
      WRITE(KOUT1,619)
  619 FORMAT(1X,'FOR EACH RECEPTION COUNTY INPUT: COUNTY NO., NUMBER',
     1' OF PEOPLE')
      KGR=1
      NR=1
  290 NR=NR-1
      IF(NR.LT.0) NR=0
  300 CONTINUE
      READ(KIN1,*,ERR=300) J1,NUM
      IF(J1.EQ.999) GO TO 350
      IF(J1.LE.0) GO TO 290
      NR=NR+1
      JT=J1/1000
      JC=(J1-1000*JT+1)/2
      J=LOCK(JT,JC,0,NOLOC,NODES)
      DV(NR)=NUM
      JR(NR)=J
      IF(J.EQ.0) GO TO 305
```

```
      WRITE(KOUT1,605) NR,DV(NR),(ANAMES(K,J),K=1,7)
      JV(NR)=1
      GO TO 300
  305 WRITE(KOUT1,651)
      GO TO 290
  310 WRITE(KOUT1,619)
  619 FORMAT(1X,'INPUT MINIMUM, MAXIMUM PRE-EVACUATION RECEPTION AREA DE
     1NSITY IN PEOPLE/SQ. MILE')
      READ(KIN1,*,ERR=310) MIND,MAXD
      DMIN=MIND
      DMAX=MAXD
  320 WRITE(KOUT1,620)
  620 FORMAT(1X,'INPUT MINIMUM, MAXIMUM TRAVEL TIME IN HOURS X 100')
      READ(KIN1,*,ERR=320) MINT,MAXT
      TMIN=FLOAT(MINT)/100.0
      TMAX=FLOAT(MAXT)/100.0
  330 WRITE(KOUT1,621)
  621 FORMAT(1X,'INPUT MAXIMUM RESIDENT POPULATION MULTIPLE X 100')
      READ(KIN1,*,ERR=330) MP
      IF(MP.EQ.0) MP=100000
      PM=FLOAT(MP)/100.0
      NR=0
      DO 340 J=1,NN
      IF(XLLOC(2,J).EQ.0.0) GO TO 340
      DEN=XLLOC(1,J)/XLLOC(2,J)
      IF(DEN.LE.DMIN.OR.DEN.GE.DMAX) GO TO 340
  334 DO 336 I=1,NE
      IF(J.EQ.JE(I)) GO TO 340
  336 CONTINUE
      NR=NR+1
      DV(NR)=1.0E10
      JR(NR)=J
  340 CONTINUE
  350 CONTINUE
      IF(NE.EQ.0.OR.NR.EQ.0) GO TO 410
  395 RMAX=1.0E10
      IF(KGR.EQ.1) GO TO 405
  400 WRITE(KOUT1,627)
  627 FORMAT(1X,'INPUT POST EVACUATION MAXIMUM DENSITY IN RECEPTION COUN
     1TIES IN PEOPLE/SQ. MILE')
      READ(KIN1,*,ERR=400) MAXR
      RMAX=MAXR
  405 DO 23 I=1,NE
      J=JE(I)
      IF(SV(I).GE.0.0) GO TO 22
      SV(I)=-SV(I)
      GO TO 23
   22 STEST=XLLOC(1,J)-EMAX*XLLOC(2,J)
      IF(STEST.GT.SV(I)) SV(I)=STEST
   23 CONTINUE
      IF(KGR.EQ.1) GO TO 29
      DO 27 I=1,NR
      J=JR(I)
   26 DEN=XLLOC(1,J)/XLLOC(2,J)
      IF(RMAX.LE.DEN) DV(I)=0.0
      PMAX=(RMAX-DEN)*XLLOC(2,J)
      JV(I)=2
      IF(PMAX.LE.0.0) GO TO 27
      IF(PM*DEN.GE.RMAX) GO TO 25
      PMAX=(PM-1.0)*DEN*XLLOC(2,J)
      IF(PMAX.LT.DV(I)) JV(I)=3
   25 IF(PMAX.LT.DV(I)) DV(I)=PMAX
   27 CONTINUE
   29 M=NE+1
      N=NR
  410 SS=0.0
      DS=0.0
      IF(NE.EQ.0) GO TO 420
      DO 30 I=1,NE
   30 SS=SS+SV(I)
  420 IF(NR.EQ.0) GO TO 430
      DO 40 J=1,NR
   40 DS=DS+DV(J)
      SV(M)=0.0
```

```
430 WRITE(KOUT1,625) NE,SS,NR,DS
625 FORMAT(/1X,'NUMBER OF EVACUATED COUNTIES',I4,5X,'EVACUATED POPULAT
   1ION   ',F12.0/1X,'NUMBER OF RECEPTION COUNTIES',I4,5X,'RECEPTION A
   2REA CAPACITY',F12.0)
    IF(KGE.EQ.1) GO TO 42
    PEV=100.0*PEV
    WRITE(KOUT1,652) KV,PEV
    IF(KF.EQ.1) WRITE(KOUT1,653)
 42 IF(KGR.EQ.1) GO TO 44
    WRITE(KOUT1,654) DMIN,DMAX,TMIN,TMAX,PM
 44 IF(KGE.EQ.0) WRITE(KOUT1,655) EMAX
    IF(KGR.EQ.0) WRITE(KOUT1,656) RMAX
    IF(KOUT2.EQ.6) GO TO 46
    CALL HEADER(KOUT2,1.0)
    WRITE(KOUT2,625) NE,SS,NR,DS
    IF(KGE.EQ.1) GO TO 52
    WRITE(KOUT2,652) KV,PEV
    IF(KF.EQ.1) WRITE(KOUT2,653)
 52 IF(KGR.EQ.1) GO TO 54
    WRITE(KOUT2,654) DMIN,DMAX,TMIN,TMAX,PM
 54 IF(KGE.EQ.0) WRITE(KOUT2,655) EMAX
    IF(KGR.EQ.0) WRITE(KOUT2,656) RMAX
 46 WRITE(KOUT1,657)
    READ(KIN1,512,ERR=46) AYN
    IF(AYN.NE.OK) RETURN
512 FORMAT(A2)
652 FORMAT(1X,'VULNERABILITY GROUP CODE: ',I2/
   11X,'MINIMUM EVACUATED POPULATION: ',F6.0,' PERCENT')
653 FORMAT(1X,'COUNTERFORCE TARGETS ARE EVACUATED')
654 FORMAT(' MINIMUM RECEPTION AREA DENSITY: ',F6.0,' PEOPLE/SQ MILE'/
   11X,'MAXIMUM RECEPTION AREA DENSITY: ',F6.0,' PEOPLE/SQ MILE'/
   21X,'MINIMUM TRAVEL TIME TO RECEPTION AREAS: ',F6.2,' HOURS'/
   31X,'MAXIMUM TRAVEL TIME TO RECEPTION AREAS: ',F6.2,' HOURS'/
   41X,'MAXIMUM RESIDENT POPULATION MULTIPLE: ',F6.2)
655 FORMAT(1X,'POST EVACUATION MAXIMUM DENSITY IN EVACUATED AREAS: ',
   1F6.0)
656 FORMAT(1X,'POST EVACUATION MAXIMUM DENSITY IN RECEPTION AREAS: ',
   1F6.0)
657 FORMAT(/1X,'TYPE "OK" TO COMPUTE EVACUATION PLAN')
    K1=0
   K2=0
    K6=0
    IF(NE.EQ.0.OR.NR.EQ.0.OR.SS.GT.DS) GO TO 140
    IF(KOUT2.NE.6) CALL HEADER(KOUT2,1.1)
    WRITE(KOUT2,631)
    DO 450 IE=1,NE
    I=JE(IE)
    REC=0.0
    DO 440 J=1,NR
    JY=JR(J)
    IF(Y(JY,IE).GE.TMIN.AND.Y(JY,IE).LE.TMAX) REC=REC+DV(J)
    DEN=XLLOC(1,I)/XLLOC(2,I)
440 CONTINUE
    WRITE(KOUT2,628) (ANAMES(K,I),K=5,7),XLLOC(1,I),XLLOC(2,I),DEN,SV(
   1IE),REC
450 CONTINUE
631 FORMAT(/1X,'EVACUATION COUNTY',4X,'RESIDENTS',6X,'AREA',
   13X,'DENSITY',3X,'AT RISK POP.',2X,'REC. CAPACITY')
628 FORMAT(1X,3A4,8X,2F10.0,F10.2,2F15.0)
629 FORMAT(/1X,'RECEPTION COUNTY',5X,'RESIDENTS',6X,'AREA',
   13X,'DENSITY',6X,'CRITERION',2X,'REC. CAPACITY')
    WRITE(KOUT2,629)
    DO 460 J=1,NR
    JY=JR(J)
    DEN=XLLOC(1,JY)/XLLOC(2,JY)
    IF(JV(J).EQ.1) WRITE(KOUT2,632) (ANAMES(K,JY),K=5,7),XLLOC(1,JY),X
   1LLOC(2,JY),DEN,DV(J)
    IF(JV(J).EQ.2) WRITE(KOUT2,633) (ANAMES(K,JY),K=5,7),XLLOC(1,JY),X
   1LLOC(2,JY),DEN,DV(J)
    IF(JV(J).EQ.3) WRITE(KOUT2,634) (ANAMES(K,JY),K=5,7),XLLOC(1,JY),X
   1LLOC(2,JY),DEN,DV(J)
632 FORMAT(1X,3A4,8X,2F10.0,F10.2,10X,'GIVEN',F15.0)
633 FORMAT(1X,3A4,8X,2F10.0,F10.2,8X,'DENSITY',F15.0)
634 FORMAT(1X,3A4,8X,2F10.0,F10.2,7X,'MULTIPLE',F15.0)
460 CONTINUE
```

```
      IF(SS.LT.DS) SV(M)=DS-SS
      DO 50 I=1,NE
      DO 50 J=1,NR
      JA=M*(J-1)+I
      JY=JR(J)
      A(JA)=Y(JY,I)
      IF(A(JA).LT.TMIN.OR.A(JA).GT.TMAX) A(JA)=1000.0+A(JA)
   50 CONTINUE
      DO 70 J=1,NR
      JA=M*J
   70 A(JA)=0.0
      I1=1
      CALL TRNPLX(I1,K1,K2,K6,X0,M,N,B,A,SV,DV,Z,P,R,S,S(101),DFR,
     1IV,JV)
      IF(K1.NE.1) GO TO 140
      NO=M+N-1
      NPR=0
      DO 120 J=1,NO
      IF(Z(J).LE.1.0) GO TO 120
      IE=IV(J)
      IF(IE.EQ.M) GO TO 120
      NPR=NPR+1
      IJPR(1,NPR)=JE(IE)
      IR=JV(J)
      IJPR(2,NPR)=JR(IR)
      DENPR(NPR)=Z(J)
C     WRITE(6,667) J,IE,IR,NPR,IJPR(1,NPR),IJPR(2,NPR),DENPR(NPR)
      JA=M*(IR-1)+IE
      S(NPR)=A(JA)
  667 FORMAT(1X,6I6,F12.1)
  120 CONTINUE
  125 IF(NPR.LE.0) GO TO 140
      INFS=0
      WRITE(KOUT1,635) NPR
  635 FORMAT(/1X,'EVACUATION PROBLEM IS FEASIBLE'/1X,
     1'NUMBER OF EVACUATION/RECEPTION COUNTY PAIRS',I4)
      IF(KOUT2.NE.6) CALL HEADER(KOUT2,1,2)
      WRITE(KOUT2,604)
  604 FORMAT(/1X,'EVACUATION/RECEPTAON COUNTY PAIRS'/1X,'PAIR     PEOPLE
     1    ORIGIN',10X,'COUNTY',10X,'DESTINATION',5X,'COUNTY',11X,'HOURS'
     2,7X,'MILES',5X,'DENSITY')
      DO 130 J=1,NPR
      IF(J.EQ.NPR) GO TO 127
      JS=J+1
      DO 126 K=JS,NPR
      IF(S(J).GE.S(K)) GO TO 126
      I1=IJPR(1,J)
      J1=IJPR(2,J)
      S1=S(J)
      P1=DENPR(J)
      IJPR(1,J)=IJPR(1,K)
      IJPR(2,J)=IJPR(2,K)
      S(J)=S(K)
      DENPR(J)=DENPR(K)
      IJPR(1,K)=I1
      IJPR(2,K)=J1
      S(K)=S1
      DENPR(K)=P1
  126 CONTINUE
  127 I1=IJPR(1,J)
      J1=IJPR(2,J)
      DO 128 IE=1,NE
      IF(JE(IE).EQ.I1) GO TO 129
  128 CONTINUE
  129 CALL ROUTE(J1,I1,IFNO,1,IJR,CR,Y(1,IE),A,LFR,IFR,MFR,CFR,
     1OMIT(1,1),NODES)
      DST=0.0
      NF=IJR(1,1)+1
      DO 135 J0=3,NF
      L=IJR(J0,1)
  135 DST=DST+DSTLNK(L)
      DEN=XLLOC(1,J1)
      DO 150 K=1,NPR
      IF(IJPR(2,K).EQ.J1) DEN=DEN+DENPR(K)
  150 CONTINUE
```

```
      DEN=DEN/XLLOC(2,J1)
      WRITE(KOUT2,605) J,DENPR(J),(ANAMES(K,I1),K=1,7),(ANAMES(K,J1),K=1
     1,7),S(J),DST,DEN
  605 FORMAT(1X,I4,2X,F10.0,3X,7A4,4X,7A4,2X,F8.2,F12.0,F12.2)
  130 CONTINUE
  601 FORMAT(1X,I3,2I8,F8.1)
      RETURN
  140 WRITE(KOUT1,602)  K1,K2,K6
  602 FORMAT(1X,'EVACUATION PROBLEM IS NOT FEASIBLE',3I6)
      IFB=1
      RETURN
      END




      SUBROUTINE LOADL(L,NRT,HRS,PV,XL,TIMES,NX,NTOT)
C LOAD LINK L
      DIMENSION XL(21,1),TIMES(15),XN(15),NX(1)
       INCLUDE SOURCE.INSERT
      DO 10 KT=1,14
   10 XN(KT)=0.0
      DO 50 JRT=1,NRT
      IF(DR(JRT).LE.100.0) GO TO 50
      NF=IJR(1,JRT)+1
      DO 50 J=3,NF
      J1=NF-J+3
      IF(IJR(J1,JRT).NE.L) GO TO 50
      J0=J1-1
      TYM=TIMER(JRT,PV,HRS,T1,T2)
      TYM=2.0*T2
      DEN=DR(JRT)/(TYM*PV)
      DO 45 KT=1,14
      T=TIMES(KT)
      XAD=0.0
      IF(XL(J0,JRT).EQ.XL(J1,JRT)) GO TO 40
   25 XAD=DEN
      IF(T.GT.XL(J0,JRT).AND.T.LT.XL(J1,JRT)+TYM) GO TO 40
      XAD=0.0
      IF(T.LT.XL(J1,JRT).OR.T.GT.XL(J0,JRT)+TYM) GO TO 40
      IF(T.GE.XL(J1,JRT)+TYM) GO TO 30
      XAD=((T-XL(J1,JRT))/(XL(J0,JRT)-XL(J1,JRT)))*DEN
      GO TO 40
   30 XAD=((XL(J0,JRT)+TYM-T)/(XL(J0,JRT)-XL(J1,JRT)))*DEN
   40 CONTINUE
      XN(KT)=XN(KT)+XAD
C     WRITE(6,600) JRT,J,J1,T,XAD,XL(J0,JRT),XL(J1,JRT)
   45 CONTINUE
   50 CONTINUE
      NTOT=0
      DO 60 KT=1,14
      X=100.0*XN(KT)
      X=X/BFR(L)+.4999
      NX(KT)=X
   60 NTOT=NTOT+NX(KT)
  600 FORMAT(1X,3I5,4F12.4)
      RETURN
      END




      SUBROUTINE EVAC(KOUT1,KOUT2,NN,NL,HRS,PV,NRT,XL,XD,XS)
C SIMULATE THE EVACUATION
       INCLUDE SOURCE.INSERT
      DIMENSION XL(21,1),TIMES(15),XD(15,1),XS(15,1),NX(15)
      DATA TIMES /2.,4.,6.,8.,12.,16.,20.,24.,32.,40.,48.,60.,72.,84./
      DO 100 I=1,15
      DO 90 J=1,500
   90 XD(I,J)=0.0
      XS(I,1)=0.0
      XS(I,2)=0.0
  100 XS(I,3)=0.0
```

```
      NE=0
      NR=100
      DO 200 KRT=1,NRT
      KPR=IJR(2,KRT)
      JR=IJPR(1,KPR)
      IS=IJPR(2,KPR)
      IF(NE.EQ.0) GO TO 120
      DO 110 I=1,NE
      IF(JR.EQ.ISS(I)) GO TO 130
  110 CONTINUE
  120 NE=NE+1
      ISS(NE)=JR
      I=NE
  130 IF(NR.EQ.100) GO TO 150
      DO 140 J=101,NR
      IF(IS.EQ.ISS(J)) GO TO 160
  140 CONTINUE
  150 NR=NR+1
      ISS(NR)=IS
      J=NR
  160 DO 190 KT=1,14
      T=TIMES(KT)
      TS=TIMER(KRT,PV,HRS,T1,T2)
      FD=1.0
      IF(T.GE.2.0*T2) GO TO 170
      FD=T/(2.0*T2)
  170 FA=1.0
      IF(T.GE.T1+2.0*T2) GO TO 180
      FA=0.0
      IF(T.LE.T1) GO TO 180
      FA=(T-T1)/(2.0*T2)
  180 XD(KT,I)=XD(KT,I)+FD*DR(KRT)
      XD(KT,J)=XD(KT,J)+FA*DR(KRT)
      XS(KT,1)=XS(KT,1)+(1.0-FD)*DR(KRT)
      XS(KT,2)=XS(KT,2)+(FD-FA)*DR(KRT)
      XS(KT,3)=XS(KT,3)+FA*DR(KRT)
  190 CONTINUE
      XD(15,I)=XD(15,I)+DR(KRT)
      XD(15,J)=XD(15,J)+DR(KRT)
      XS(15,1)=XS(15,1)+DR(KRT)
  200 CONTINUE
      WRITE(KOUT1,611) XS(15,1)
      IF(KOUT2.EQ.6) GO TO 210
      CALL HEADER(KOUT2,3.0)
      WRITE(KOUT2,611) XS(15,1)
  210 DO 230 K=1,3
      DO 220 KT=1,14
      X=100.0*XS(KT,K)/XS(15,1)
  220 NX(KT)=X
      IF(K.EQ.1) WRITE(KOUT1,612) (NX(KT),KT=1,14)
      IF(K.EQ.2) WRITE(KOUT1,613) (NX(KT),KT=1,14)
      IF(K.EQ.3) WRITE(KOUT1,614) (NX(KT),KT=1,14)
      IF(KOUT2.EQ.6) GO TO 230
      IF(K.EQ.1) WRITE(KOUT2,612) (NX(KT),KT=1,14)
      IF(K.EQ.2) WRITE(KOUT2,613) (NX(KT),KT=1,14)
      IF(K.EQ.3) WRITE(KOUT2,614) (NX(KT),KT=1,14)
  230 CONTINUE
  611 FORMAT(/1X,'EVACUEES: ',F10.0,5X,'ELAPSED HOURS: ','    2    4',
     1'    6    8   12   16   20   24   32   40   48   60   72   84')
  612 FORMAT(1X,'PERCENTAGE OF EVACUEES AT RISK',10X,14I5)
  613 FORMAT(1X,'PERCENTAGE OF EVACUEES EN ROUTE',9X,14I5)
  614 FORMAT(1X,'PERCENTAGE OF EVACUEES AT DESTINATION',3X,14I5)
      IF(KOUT2.NE.6) CALL HEADER(KOUT2,3.1)
      WRITE(KOUT2,615)
      DO 250 I=1,NE
      DO 240 KT=1,14
      X=100.0*XD(KT,I)/XD(15,I)
  240 NX(KT)=X
      JR=ISS(I)
  250 WRITE(KOUT2,616) (ANAMES(K,JR),K=5,7),XD(15,I),(NX(KT),KT=1,14)
      IF(KOUT2.NE.6) CALL HEADER(KOUT2,3.2)
      WRITE(KOUT2,617)
      DO 280 J=101,NR
      DO 270 KT=1,14
      X=100.0*XD(KT,J)/XD(15,J)
  270 NX(KT)=X
      IS=ISS(J)
```

```
280 WRITE(KOUT2,616) (ANAMES(K,IS),K=5,7),XD(15,J),(NX(KT),KT=1,14)
615 FORMAT(/1X,'EVACUATION DEPARTURE SUMMARY'/
   11X,'EVACUATION COUNTY  EVACUEES',19X,'PERCENTAGE DEPARTED AT ',
   2'ELAPSED HOUR'/30X,'    2    4    6',
   3'    8   12   16   20   24   32   40   48   60   72   84')
616 FORMAT(1X,3A4,5X,F10.0,2X,14I5)
617 FORMAT(/1X,'RECEPTION ARRIVAL SUMMARY'/
   11X,'RECEPTION COUNTY  EVACUEES',20X,'PERCENTAGE ARRIVED AT ',
   2'ELAPSED HOUR'/30X,'    2    4    6',
   3'    8   12   16   20   24   32   40   48   60   72   84')
    IF(KOUT2.NE.6) CALL HEADER(KOUT2,3.3)
    WRITE(KOUT2,600)
    WRITE(KOUT2,601)
    DO 30 I=1,NN
    LS=LFR(I)
    LF=LFR(I+1)-1
    DO 20 L=LS,LF
    IF(DFR(L).EQ.1.0E5) GO TO 20
    IF(DFR(L)/(PV*BFR(L)).LT.HRS) GO TO 20
    J=IFR(L)
    NH=MFR(L)-1000*(MFR(L)/1000)
    KH=MFR(L)/10000+1
    CALL LOADL(L,NRT,HRS,PV,XL,TIMES,NX,NTOT)
    IF(NTOT.LT.1) GO TO 20
    IF(KH.EQ.1) WRITE(KOUT2,604) (ANAMES(K,J),K=1,4),(ANAMES(K,I),K=1,
   14),NH,DSTLNK(L),SPDLNK(L),BFR(L),(NX(KT),KT=1,14)
    IF(KH.EQ.2) WRITE(KOUT2,603) (ANAMES(K,J),K=1,4),(ANAMES(K,I),K=1,
   14),NH,DSTLNK(L),SPDLNK(L),BFR(L),(NX(KT),KT=1,14)
    IF(KH.EQ.3) WRITE(KOUT2,602) (ANAMES(K,J),K=1,4),(ANAMES(K,I),K=1,
   14),NH,DSTLNK(L),SPDLNK(L),BFR(L),(NX(KT),KT=1,14)
604 FORMAT(1X,4A4,3X,4A4,3X,'INTERSTATE',I4,2F7.1,F8.0,14I4)
603 FORMAT(1X,4A4,3X,4A4,3X,'U.S. ROUTE',I4,2F7.1,F8.0,14I4)
602 FORMAT(1X,4A4,3X,4A4,3X,'STATE ROAD',I4,2F7.1,F8.0,14I4)
 20 CONTINUE
 30 CONTINUE
600 FORMAT(/1X,'NETWORK LINK CHARACTERISTICS AND LOADINGS')
601 FORMAT(1X,'FROM',15X,'TO',17X,'ROUTE NAME',4X,'  DIST.  SPEED',
   1'    CAP.',6X,'PERCENTAGE OF CAPACITY IN USE AT ELAPSED HOUR',
   2/75X,'   2   4   6   8  12  16  20  24  32  40  48  60  72  84')
    RETURN
    END
```

```
      SUBROUTINE LOADER(NRT,NL,KTCC)
C LOAD NETWORK LINKS
       INCLUDE SOURCE.INSERT
      DO 5 L=1,NL
      DFR(L)=0.0
    5 CONTINUE
      DO 130 JRT=1,NRT
      IF(DR(JRT).LE.1.0) GO TO 130
      NF=IJR(1,JRT)+1
      DO 120 J=3,NF
      L=IJR(J,JRT)
      LO=JTO(L)
  110 DFR(L)=DFR(L)+DR(JRT)
      IF(KTCC.NE.3) GO TO 120
  115 DFR(LO)=DFR(LO)+DR(JRT)
  120 CONTINUE
  130 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BLOCK(KOUT1,KOUT2,NN,NL,KTCC,PV,HRS,T1,NIT,NRT)
C DELETE CAPACITATED LINKS
       INCLUDE SOURCE.INSERT
      T1=0.0
      L0=0
      DO 10 L=1,NL
      IF(OMIT(L,1)) GO TO 10
      IF(BFR(L).EQ.1.0E-5) GO TO 10
      T2=DFR(L)/(PV*BFR(L))
      IF(T2.LE.T1) GO TO 10
      T1=T2
      L0=L
   10 CONTINUE
      IF(L0.EQ.0) RETURN
      IF(NIT.EQ.1) WRITE(KOUT1,601)
      IF(NIT.EQ.1.AND.KOUT2.NE.6) WRITE(KOUT2,601)
      T3=0.90*T1
      DO 50 I=1,NN
      LS=LFR(I)
      LF=LFR(I+1)-1
      DO 50 L=LS,LF
      IF(OMIT(L,1)) GO TO 50
      T2=DFR(L)/(PV*BFR(L))
      IF(T2.LT.T3) GO TO 50
      IF(DFR(L).EQ.1.0E5) GO TO 30
      J=IFR(L)
      NH=MFR(L)-1000*(MFR(L)/1000)
      KH=MFR(L)/10000+1
      T0=T2/2.0
      VCLS=DFR(L)/PV
      IF(L0.GT.0.AND.KH.EQ.1) WRITE(KOUT1,602) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.GT.0.AND.KH.EQ.2) WRITE(KOUT1,603) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.GT.0.AND.KH.EQ.3) WRITE(KOUT1,604) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.1) WRITE(KOUT1,605) BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.2) WRITE(KOUT1,606) BFR(L),VCLS,T0,
     2(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.3) WRITE(KOUT1,607) BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(KOUT2.EQ.6) GO TO 30
      IF(L0.GT.0.AND.KH.EQ.1) WRITE(KOUT2,602) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.GT.0.AND.KH.EQ.2) WRITE(KOUT2,603) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.GT.0.AND.KH.EQ.3) WRITE(KOUT2,604) NIT,NRT,BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.1) WRITE(KOUT2,605) BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.2) WRITE(KOUT2,606) BFR(L),VCLS,T0,
     2(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
      IF(L0.EQ.0.AND.KH.EQ.3) WRITE(KOUT2,607) BFR(L),VCLS,T0,
     1(ANAMES(K,J),K=1,7),(ANAMES(K,I),K=1,7),NH
   30 OMIT(L,1)=.TRUE.
      L0=0
      IF(KTCC.EQ.2.AND.T1.GT.HRS) BFR(L)=2.0*BFR(L)
   40 K=JTO(L)
      OMIT(K,2)=.TRUE.
      IF(KTCC.EQ.2.AND.T1.GT.HRS) BFR(K)=1.0E-5
      IF(KTCC.EQ.2) OMIT(K,1)=.TRUE.
   50 CONTINUE
  601 FORMAT(/1X,'PASS ROUTES  CAPACITY  VEHICLES  DELAY   FROM',
     112X,'COUNTY',10X,'TO',14X,'COUNTY',10X,'ROUTE NAME')
  602 FORMAT(1X,I3,I7,1X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'INTERSTATE',I4)
  603 FORMAT(1X,I3,I7,1X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'U.S. ROUTE',I4)
  604 FORMAT(1X,I3,I7,1X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'STATE ROAD',I4)
  605 FORMAT(12X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'INTERSTATE',I4)
  606 FORMAT(12X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'U.S. ROUTE',I4)
  607 FORMAT(12X,2F10.0,F7.2,3X,7A4,4X,7A4,4X,'STATE ROAD',I4)
      IF(T1.LT.HRS) T1=HRS
      RETURN
      END
```

```
      FUNCTION IFSAME(JRT,NRT,IJR)
      DIMENSION IJR(21,1)
      IFSAME=0
      IF(NRT.LE.0) RETURN
      NJ=IJR(1,JRT)+1
      DO 20 KRT=1,NRT
      NK=IJR(1,KRT)+1
      IF(NJ.NE.NK) GO TO 20
      DO 10 I=2,NJ
      IF(IJR(I,JRT).NE.IJR(I,KRT)) GO TO 20
   10 CONTINUE
      IFSAME=1
      RETURN
   20 CONTINUE
      RETURN
      END
```

```
      FUNCTION TIMER(KRT,PV,HRS,T1,T2)
C COMPUTE LONGEST TIME ON ROUTE
       INCLUDE SOURCE.INSERT
      T1=CR(KRT)
   30 T2=HRS/2.0
      NF=IJR(1,KRT)+1
      DO 40 J=3,NF
      L=IJR(J,KRT)
      T3=DFR(L)/(2.0*PV*BFR(L))
      IF(T2.GE.T3) GO TO 40
      T2=T3
   40 CONTINUE
      TIMER=T1+T2
      RETURN
      END
```

```
      SUBROUTINE HEADER(IFILE,XNUM)
C ATTACH HEADER
      WRITE(IFILE,601) XNUM
  601 FORMAT(///1H1,'TABLE ',F3.1)
      RETURN
      END
```

```
      SUBROUTINE TRNPLX(I1,K1,K2,K6,X0,M,N,B,C,S0,D0,X,P,R,S,D,Y,I,J)
C MAIN CALLING SEQUENCE
      LOGICAL B
      REAL*8 X,P,R,X0,R0,A1,D1
      DIMENSION B(1),C(1),S(1),D(1),X(1),P(1),R(1),S0(1),D0(1),Y(1),I(1)
     1,J(1)
      L=M+N-1
      T2=1.0E-6
      T3=-1.0E-6
      K2=0
      I17=M*N
      R0=-1.0E19
      T0=0.0
      DO 5 I0=1,M
      T0=T0+S0(I0)
      DO 5 J0=1,N
      K0=M*(J0-1)+I0
      IF(R0.LT.C(K0)) R0=C(K0)
    5 CONTINUE
      R0=1.01*R0
      T2=T2*T0
      T3=T3*R0
      KF9=0
```

```
      GO TO(10,20),I1
   10 CALL NEW(M,N,L,R0,T2,T3,B,C,S,D,S0,D0,X,P,R)
   20 CALL RESET(M,N,L,K6,X0,B,C,S,D,S0,D0,I,J,X)
   30 CALL XCK(J1,M,L,T2,I,J,X)
      IF(KF9.EQ.1) GO TO 50
      KF9=1
      GO TO(50,40), I1
   40 IF(J1.EQ.0) GO TO 60
   50 IF(K6.LT.J1) GO TO 20
      IF(K6.EQ.J1) GO TO 70
   60 K6=0
   70 CALL SET(M,N,L,R0,K6,T2,C,I,J,X,P,R)
      D3=T3
      CALL MIN(I7,J7,D1,D3,K6,T3,M,N,B,C,P,R)
      IF(I7.GT.0) GO TO 80
   75 K1=1+K6
      RETURN
   80 CALL DELTA(I7,J7,L,L1,I,J,X,Y)
      CALL ROW(K9,A1,L1,T2,X,Y)
      IF(K9.GT.0) GO TO 90
      K1=3
      RETURN
   90 IF(K2.GE.I17) GO TO 100
      CALL PIVOT(M,K9,I7,J7,L1,A1,X0,B,C,I,J,X,Y)
   95 K2=K2+1
      GO TO 30
  100 K1=4
      RETURN
      END


      SUBROUTINE RESET(M,N,L,K6,X0,B,C,S,D,S0,D0,I,J,X)
C RESET S,D,I,J AND X
      LOGICAL B
      REAL*8 X,X0,S7
      DIMENSION B(1),C(1),S(1),D(1),S0(1),D0(1),I(1),J(1),X(1)
      CALL RESD(M,N,S,D,S0,D0)
      K6=1
      X0=0.0
      K=1
      DO 20 I1=1,M
      DO 20 J1=1,N
      K7=M*(J1-1)+I1
      IF(B(K7)) GO TO 10
      I(K)=I1
      J(K)=J1
      K=K+1
   10 B(K7)=.TRUE.
   20 CONTINUE
   25 L1=0
      DO 70 K=1,L
      I7=I(K)
      J7=J(K)
      K7=M*(J7-1)+I7
      IF(.NOT.B(K7)) GO TO 70
      S7=S(I7)
      DO 30 IH=1,L
      IF(I(IH).NE.I7.OR.IH.EQ.K) GO TO 30
      KH=M*(J(IH)-1)+I7
      IF(B(KH)) GO TO 40
      S7=S7-X(IH)
   30 CONTINUE
      GO TO 60
   40 S7=D(J7)
      DO 50 IH=1,L
      IF(J(IH).NE.J7.OR.IH.EQ.K) GO TO 50
      KH=M*(J7-1)+I(IH)
      IF(B(KH)) GO TO 65
      S7=S7-X(IH)
   50 CONTINUE
   60 B(K7)=.NOT.B(K7)
      X(K)=S7
      GO TO 70
   65 L1=1
   70 CONTINUE
      IF(L1.EQ.1) GO TO 25
      DO 80 K=1,L
      K7=M*(J(K)-1)+I(K)
   80 X0=X0+C(K7)*X(K)
      RETURN
      END
```

```
      SUBROUTINE XCK(J1,M,L,T2,I,J,X)
C RESET X AND CHECK FOR INFEASIBILITY
      REAL*8 X
      DIMENSION I(1),J(1),X(1)
      J1=0
      DO 10 K=1,L
      K7=I(K)+(J(K)-1)*M
      IF(DABS(X(K)).LT.T2) X(K)=0.0
      IF(X(K).LT.-T2) J1=1
   10 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SWAP(K,L1,I,J,X)
C SWAP LOCATIONS IN I,J AND X
      REAL*8 X,X9
      DIMENSION I(1),J(1),X(1)
      I9=I(L1)
      I(L1)=I(K)
      I(K)=I9
      I9=J(L1)
      J(L1)=J(K)
      J(K)=I9
      X9=X(L1)
      X(L1)=X(K)
      X(K)=X9
      RETURN
      END
```

```
      SUBROUTINE RESD(M,N,S,D,S0,D0)
C RESET S & D FROM S0 & D0
      DIMENSION S(1),D(1),S0(1),D0(1)
      DO 10 I=1,M
   10 S(I)=S0(I)
      DO 20 J=1,N
   20 D(J)=D0(J)
      RETURN
      END
```

```
      SUBROUTINE ROW(K9,A1,L1,T2,X,Y)
C ROW SELECTION
      REAL*8 X,A1
      DIMENSION X(1),Y(1)
      K9=0
      A1=1.0E20
      DO 10 K=1,L1
      IF(X(K).LT.-T2.OR.Y(K).LT.0.0) GO TO 10
      IF(X(K).GE.A1) GO TO 10
      K9=K
      A1=X(K)
   10 CONTINUE
      DO 20 K=1,L1
      IF(X(K).LT.-T2.AND.X(K).GE.-A1.AND.Y(K).LT.0.0) GO TO 30
   20 CONTINUE
      RETURN
   30 K9=K
      A1=-X(K)
      RETURN
      END
```

```
      SUBROUTINE GET(M,N,L,R0,K6,T2,C,I,J,X,P,R
C GET PRICES
      REAL*8 X,P,R,R0,C0
      DIMENSION I(1),J(1),C(1),P(1),R(1),X(1)
      DO 10 I1=1,M
   10 P(I1)=0.0
      DO 20 J1=1,N
   20 R(J1)=0.0
      R(N)=R0
   25 L1=0
      DO 50 K=1,L
      I0=I(K)
      J0=J(K)
      K7=I0+(J0-1)*M
      C0=C(K7)
      IF(K6.EQ.0) GO TO 30
      IF(X(K).GE.-T2) C0=0.0
      IF(X(K).LT.-T2) C0=-R0+1.0
   30 IF(P(I0).GT.0.0.AND.R(J0).GT.0.0) GO TO 50
      IF(P(I0).EQ.0.0.AND.R(J0).EQ.0.0) GO TO 40
      IF(P(I0).EQ.0.0) P(I0)=R(J0)-C0
      IF(R(J0).EQ.0.0) R(J0)=P(I0)+C0
      GO TO 50
   40 L1=1
   50 CONTINUE
      IF(L1.GT.0) GO TO 25
      RETURN
      END
```

```
      SUBROUTINE DELTA(I7,J7,L,L1,I,J,X,Y)
C COMPUTE PER UNIT CHANGES IN BASIS VARIABLES
      REAL*8 X
      DIMENSION I(1),J(1),X(1),Y(1)
      I0=I7
      J0=J7
      L0=0
      L1=1
      L2=L
      K7=0
    5 DO 10 K=L1,L2
      IF(K7.EQ.0.AND.I(K).EQ.I0) GO TO 15
      IF(K7.EQ.1.AND.J(K).EQ.J0) GO TO 15
   10 CONTINUE
      IF(L0.EQ.0) GO TO 20
      L1=L0
      K=L2
      L0=L0-1
      L2=L2-1
      CALL SWAP(K,L1,I,J,X)
      GO TO 20
   15 IF(K.GT.L1) CALL SWAP(K,L1,I,J,X)
      IF(K7.EQ.0.AND.J(L1).EQ.J7) GO TO 40
      IF(K7.EQ.1.AND.I(L1).EQ.I7) GO TO 40
      L0=L0+1
      L1=L1+1
   20 K7=1-K7
      IF(L0.EQ.0) GO TO 30
      I0=I(L0)
      J0=J(L0)
      GO TO 5
   30 I0=I7
      J0=J7
      GO TO 5
   40 DO 50 K=1,L
   50 Y(K)=0.0
      S7=1.0
      DO 60 K=1,L1
      Y(K)=S7
   60 S7=-S7
      RETURN
      END
```

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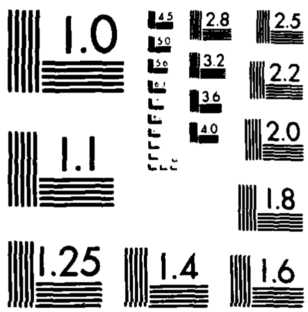

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      SUBROUTINE MIN(I7,J7,D1,D3,K6,T3,M,N,B,C,P,R)
C MIN D-J, SELECTS VARIABLE TO ENTER BASIS
      LOGICAL B
      REAL*8 P,R,D1,D2
      DIMENSION B(1),C(1),P(1),R(1)
      I7=0
      D1=D3
      DO 20 I=1,M
      DO 10 J=1,N
      K=M*(J-1)+I
      IF(.NOT.B(K)) GO TO 10
      D2=C(K)
      IF(K6.EQ.1) D2=0.0
      D2=D2+P(I)-R(J)
      IF(DABS(D2).LT.-T3) D2=0.0
      IF(D2.GE.D1) GO TO 10
      D1=D2
      I7=I
      J7=J
   10 CONTINUE
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE NEW(M,N,L,R0,T2,T3,B,C,S,D,S0,D0,X,P,R)
C START PHASE I
      LOGICAL B
      REAL*8 X,P,R,R0,D1
      DIMENSION B(1),S(1),D(1),S0(1),D0(1),C(1)
      DIMENSION X(1),P(1),R(1)
      CALL RESD(M,N,S,D,S0,D0)
      DO 5 I0=1,M
      DO 5 J0=1,N
      K=M*(J0-1)+I0
      B(K)=.TRUE.
    5 CONTINUE
      DO 10 I0=1,M
   10 P(I0)=-R0
      DO 20 J0=1,N
   20 R(J0)=R0
      DO 30 I0=1,M
      DO 30 J0=1,N
      K=M*(J0-1)+I0
      IF(C(K).LT.-P(I0)) P(I0)=-C(K)
   30 CONTINUE
      DO 40 J0=1,N
      DO 40 I0=1,M
      K=M*(J0-1)+I0
      IF(C(K)+P(I0).LT.R(J0)) R(J0)=C(K)+P(I0)
   40 CONTINUE
      D3=1.0E20
      K=1
      K6=0
   45 CALL MIN(I7,J7,D1,D3,K6,T3,M,N,B,C,P,R)
      K7=M*(J7-1)+I7
      IF(S(I7).LT.D(J7)+T2) P(I7)=R0
      IF(S(I7).GT.D(J7)-T2) R(J7)=-R0
      B(K7)=.FALSE.
      IF(S(I7).GT.D(J7)) GO TO 50
      D(J7)=D(J7)-S(I7)
      S(I7)=0.0
      GO TO 60
   50 S(I7)=S(I7)-D(J7)
      D(J7)=0.0
   60 K=K+1
      IF(K.LE.L) GO TO 45
      RETURN
      END
```

```
      SUBROUTINE PIVOT(M,K9,I7,J7,L1,A1,X0,B,C,I,J,X,Y)
C PIVOT
      LOGICAL B
      REAL*8 X,X0,A1
      DIMENSION B(1),C(1),I(1),J(1),X(1),Y(1)
      I9=I(K9)
      J9=J(K9)
      K=M*(J9-1)+I9
      X0=X0-C(K)*X(K9)
      B(K)=.TRUE.
      K7=M*(J7-1)+I7
      B(K7)=.FALSE.
      I(K9)=I7
      J(K9)=J7
      Y(K9)=-1.0
      X(K9)=0.0
      DO 10 K=1,L1
      K7=M*(J(K)-1)+I(K)
      X0=X0-A1*Y(K)*C(K7)
      X(K)=X(K)-A1*Y(K)
   10 CONTINUE
      RETURN
      END
```

4.5 Data Files

MAP - Map File

Field	Format	Contents
1	I6	State FIPS number
2	I6	USND starting record number
3	I6	USND ending record number
4	I6	USLD starting record number
5	I6	USLD ending record number
6	2X,4A4	State name

USND - Nodes File

Field	Format	Contents
1	I2	State FIPS number
2	I3	County FIPS number
3	4X,I1	Sequence number
4	11X,I1,4A4	Urban/Rural flag, County center name
5	8X,2F9.4	Latitude, Longitude in degrees
6	3A4	County name
7	2X,F8.0	1980 Population (or 0)
8	F8.0	County area (or 0)
9	4X,I2	FEMA risk code

USNL - Links File

Field	Format	Contents
1	I2	Origin state FIPS code
2	I3	Origin county FIPS code
3	1X,I1	Origin sequence number
4	2I5	Origin northing, easting
5	1X,I2	Destination state FIPS code
6	I3	Destination county FIPS code
7	1X,I1	Destination sequence number
8	2I5	Destination northing, easting
9	1X,I2	Route characteristics
10	I5	Highway number

MAP

1	1	72	1	200	ALABAMA
2	0	0	0	0	
3	0	0	0	0	
4	73	100	201	250	ARIZONA
5	101	176	251	412	ARKANSAS
6	177	286	413	618	CALIFORNIA
7	0	0	0	0	
8	287	359	619	770	COLORADO
9	360	396	771	870	CONNECTICUT
10	397	404	871	894	DELAWARE
11	405	405	895	907	DIST OF COLUMBIA
12	406	484	908	1116	FLORIDA
13	485	646	1117	1468	GEORGIA
14	0	0	0	0	
15	0	0	0	0	
16	647	695	1469	1555	IDAHO
17	696	808	1556	1899	ILLINOIS
18	809	907	1900	2177	INDIANA
19	908	1025	2178	2452	IOWA
20	1026	1142	2453	2698	KANSAS
21	1143	1265	2699	2988	KENTUCKY
22	1266	1331	2989	3128	LOUISIANA
23	1332	1356	3129	3185	MAINE
24	1357	1390	3186	3273	MARYLAND
25	1391	1429	3274	3385	MASSACHUSETTS
26	1430	1524	3386	3572	MICHIGAN
27	1525	1618	3573	3780	MINNESOTA
28	1619	1702	3781	3954	MISSISSIPPI
29	1703	1820	3955	4213	MISSOURI
30	1821	1882	4214	4319	MONTANA
31	1883	1978	4320	4525	NEBRASKA
32	1979	2006	4526	4581	NEVADA
33	2007	2039	4582	4673	NEW HAMPSHIRE
34	2040	2104	4674	4864	NEW JERSEY
35	2105	2144	4865	4950	NEW MEXICO
36	2145	2282	4951	5306	NEW YORK
37	2283	2383	5307	5545	NORTH CAROLINA
38	2384	2437	5546	5638	NORTH DAKOTA
39	2438	2556	5639	5982	OHIO
40	2557	2636	5983	6184	OKLAHOMA
41	2637	2687	6185	6282	OREGON
42	2688	2784	6283	6550	PENNSYLVANIA
43	0	0	0	0	
44	2785	2799	6551	6588	RHODE ISLAND
45	2800	2846	6589	6750	SOUTH CAROLINA
46	2847	2915	6751	6881	SOUTH DAKOTA
47	2916	3012	6882	7131	TENNESEE
48	3013	3297	7132	7751	TEXAS
49	3298	3331	7752	7814	UTAH
50	3332	3352	7815	7873	VERMONT
51	3353	3497	7874	8200	VIRGINIA
52	0	0	0	0	
53	3498	3549	8201	8292	WASHINGTON
54	3550	3609	8293	8429	WEST VIRGINIA
55	3610	3687	8430	8606	WISCONSIN
56	3688	3718	8607	8675	WYOMING
57	0	0	0	0	
58	0	0	0	0	
59	0	0	0	0	
60	0	0	0	0	

24001	0	114	66	0CUMBERLAND	39.6469	78.7556ALLEGANY	30548.	426.	40
24003	0	65	187	0ANNAPOLIS	38.9477	76.5142ANNE ARUNDEL	370775.	417.	00
24005	0	103	180	0COCKEYSVILLE	39.4889	76.6372BALTIMORE	655615.	[illegible]	[illegible]
24009	0	38	184	0PRINCE FREDRICK	38.5500	76.5600CALVERT	34638.	219.	40
24011	0	58	224	0DENTON	38.8500	75.8300CAROLINE	23143.	320.	00
24013	0	108	161	0WESTMINISTER	39.5689	77.0000CARROLL	96356.	456.	00
24015	0	112	226	0ELKTON	39.6200	75.7826CECIL	60430.	352.	00
24017	0	43	165	0WALDORF	38.6312	76.9156CHARLES	72751.	458.	40
24019	0	40	212	0CAMBRIDGE	38.5834	76.0558DORCHESTER	30623.	580.	00
24021	0	97	137	0FREDRICK	39.4122	77.4472FREDERICK	114263.	664.	00
24023	0	116	44	0GRANTSVILLE	39.6834	79.1698GARRETT	26498.	668.	00
24025	0	107	197	0BEL AIR	39.5600	76.3200HARFORD	145930.	448.	00
24027	0	89	169	0COLUMBIA	39.2923	76.8514HOWARD	118572.	251.	00
24029	0	82	211	0CHESTERTON	39.1922	76.0600KENT	16695.	284.	00
24031	0	81	145	0GERMANTOWN	39.1834	77.2902MONTGOMERY	579053.	494.	20
24033	0	54	177	0UPPER MARLBORO	38.7811	76.7012PRINCE GEORGES	665071.	485.	20
24035	0	68	210	0CENTERVILLE	38.9922	76.0900QUEEN ANNES	25508.	373.	00
24037	0	17	190	0LEXINGTON PARK	38.2466	76.4584ST MARYS	59895.	367.	00
24039	0	13	231	0PRINCESS ANNE	38.1967	75.6956SOMERSET	19188.	332.	00
24041	0	52	211	0EASTON	38.7600	76.0742TALBOT	25604.	279.	00
24043	0	113	120	0HAGERSTOWN	39.6389	77.7586WASHINGTON	113086.	462.	30
24045	0	25	236	0SALISBURY	38.3700	75.6000WICOMICO	64540.	380.	00
24047	0	3	239	0POCOMOKE CITY	38.0521	75.5431WORCESTER	30889.	483.	00
24510	0	90	181	1BALTIMORE	39.3100	76.6211BALTIMORE,MD P	786775.	79.	20
24003	1	61	174	0DAVIDSONVILLE	38.8899	76.7559ANNE ARUNDEL	0.	0.	00
24015	1	108	215	0PERRYVILLE	39.5622	75.9872CECIL	0.	0.	00
24021	1	117	142	0EMMITSBURG	39.7012	77.3542FREDERICK	0.	0.	00
24023	1	88	28	0REDHOUSE	39.2788	79.4674GARRETT	0.	0.	00
24025	1	105	207	0ABERDEEN	39.5311	76.1341HARFORD	0.	0.	00
24035	1	77	217	0Y	39.1223	75.9598QUEEN ANNES	0.	0.	00
24043	1	118	98	0HANCOCK	39.7112	78.1677WASHINGTON	0.	0.	00
24047	1	23	262	0OCEAN CITY	38.3412	75.1155WORCESTER	0.	0.	00
24015	2	115	208	0LIBERTY GROVE	39.6634	76.1174CECIL	0.	0.	00
24021	2	93	130	0JEFFERSON	39.3544	77.5774FREDERICK	0.	0.	00
25001	0	51	178	0SAGAMORE	41.7389	70.5233BARNSTABLE	147925.	399.	00
25003	0	99	39	1PITTSFIELD	42.4434	73.2300BERKSHIRE	145110.	942.	40
25005	0	61	149	0TAUNTON	41.8878	71.1017BRISTOL	474641.	556.	40
25007	0	29	180	0EDGARTOWN	41.4200	70.4933DUKES	8942.	106.	00
25009	0	106	154	0DANVERS	42.5455	70.9994ESSEX	633632.	500.	40
25011	0	109	73	0GREENFIELD	42.5800	72.5700FRANKLIN	64317.	722.	00
25013	0	76	76	1SPRINGFIELD	42.1100	72.5200HAMPDEN	443018.	621.	31
25015	0	94	74	0NORTHHAMPTON	42.3678	72.5417HAMPSHIRE	138813.	537.	00
25017	0	107	127	0LITTLETON	42.5523	71.5172MIDDLESEX	1367034.	829.	40
25019	0	17	201	0NANTUCKETT	41.2600	70.0900NANTUCKET	5087.	46.	40
25021	0	75	132	0FRANKLIN	42.0911	71.4261NORFOLK	606587.	398.	00
25023	0	65	172	0PLYMOUTH	41.9422	70.6450PLYMOUTH	405437.	664.	40
25025	0	91	150	1BOSTON	42.3292	71.0800SUFFOLK FSD	650142.	55.	20
25027	0	87	114	0WORCHESTER	42.2666	71.7806WORCESTER	646352.	1532.	40
25003	1	87	36	0LEE	42.2699	73.2883BERKSHIRE	0.	0.	00
25005	1	48	146	1NEW BEDFORD	41.6999	71.1600BRISTOL	0.	0.	00

24031	0	81	145	24021	0	97	137	21	701
24021	0	97	137	24043	0	113	120	21	70
24043	0	113	120	24043	1	118	98	21	70
24510	0	90	181	24027	0	89	169	21	702
24027	0	89	169	24021	0	97	137	21	702
24510	0	90	181	24005	0	103	180	21	81
24021	0	97	137	24043	0	113	120	52	40
24043	0	113	120	24043	1	118	98	52	40
24043	1	118	98	24001	0	114	66	52	40
24001	0	114	66	24023	0	116	44	52	40
24001	0	114	66	24023	0	116	44	32	48
24003	1	61	174	24003	0	65	187	32	50
24003	0	65	187	24035	0	68	210	32	50
24035	0	68	210	24041	0	52	211	42	50
24041	0	52	211	24019	0	40	212	42	50
24019	0	40	212	24045	0	25	236	42	50
24045	0	25	236	24047	1	23	262	42	50
24017	0	43	165	24037	0	17	190	43	235
24033	0	54	177	24009	0	38	184	43	4
24510	0	90	181	24003	1	61	174	43	3
24003	1	61	174	24033	0	54	177	42	301
24033	0	54	177	24017	0	43	165	42	301
24510	0	90	181	24003	0	65	187	43	505
24021	1	117	142	24021	0	97	137	52	15
24021	0	97	137	24021	2	93	130	42	15
24021	1	117	142	24013	0	108	161	53	97
24013	0	108	161	24510	0	90	181	43	97
24510	0	90	181	24025	0	107	197	52	1
24025	0	107	197	24015	2	115	208	52	1
24510	0	90	181	24025	1	105	207	21	95
24025	1	105	207	24015	1	108	215	21	95
24015	1	108	215	24015	0	112	226	21	95
24510	0	90	181	24025	1	105	207	42	40
24025	1	105	207	24015	1	108	215	42	40
24015	1	108	215	24015	0	112	226	42	40
24045	0	25	236	24039	0	13	231	42	13
24039	0	13	231	24047	0	3	239	42	13
24047	1	23	262	24047	0	3	239	52	113
24035	0	68	210	24035	1	77	217	42	301
24035	0	68	210	24011	0	58	224	53	404
24029	0	82	211	24035	1	77	217	63	213
24029	0	82	211	24015	0	112	226	63	213
24023	0	116	44	24023	1	88	28	52	219
24027	0	89	169	24510	0	90	181	32	29
11001	0	62	160	[illegible]	[illegible]	81	145	11	701
11001	0	62	160	[illegible]	0	90	181	21	95
11001	0	62	160	24510	0	90	181	23	900
11001	0	62	160	24027	0	89	169	42	29
11001	0	62	160	24510	0	90	181	52	1
11001	0	62	160	24003	1	61	174	32	50
11001	0	62	160	24033	0	54	177	33	4
11001	0	62	160	24017	0	43	165	33	5
42051	0	131	7	24023	0	116	44	52	40
42111	0	141	53	24023	0	116	44	52	219
42009	0	142	82	24001	0	114	66	52	220
42057	0	133	102	24043	1	118	98	21	70
42055	0	131	125	24043	0	113	120	21	81
42055	0	131	125	24043	0	113	120	52	11
42001	0	126	149	24021	1	117	142	42	15
42001	0	126	149	24013	0	108	161	52	140
42057	0	133	102	24043	1	118	98	52	522
42133	0	134	174	24005	0	103	180	21	81
42071	0	141	199	24015	2	115	208	52	222
42029	1	125	218	24015	2	115	208	52	1

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The IDA/BPT Crisis Relocation Planning Model: Description, Documentation and Users' Guide to the Computer Program. (IDA Record Document D-11) by Edward S. Pearsall, BPT, Robert C. Bushnell, BPT under subcontract for the Institute for Defense Analyses, (Contract FEMA EMW-C-0749C)

Abstract

This report describes work performed by Bushnell, Pearsall and Trozzo, Inc., under subcontract with the Institute for Defense Analyses on Task A-1 of IDA Contract No. EMW-C-0749 with the Federal Emergency Management Agency. Task A-1 calls for the development of "a model to simulate population movement during an evacuation from the risk area to the various host areas over a transportation network."

This report describes, documents and provides a user's guide to a system of computer routines which perform the various computations required to apply a crisis relocation model developed jointly by IDA and BPT, Inc. The computer routines together comprise an interactive system resident on the FEMA Univac 1108 facility. The model and its attached national data base can be used to analyze in detail the evacuation of risk areas anywhere in the continental United States under a wide range of different assumptions regarding the assignment of reception areas and the performance of the transportation system during the evacuation.

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